

# Safer Seating

## ISO 16840-10 Flammability

December 14, 2022 ISWP



## AGENDA

1. ISO 16840 History
2. Benefits / Risks of Seating and Flame Retardants
3. Comparison to Open Flame Standards
4. Publication
5. Evolution – Hot Wire Method
6. Hot Wire interlaboratory validation
7. Addendum to ISO 16840-10 to add Hot Wire
8. Timing

# Commitment to Test Standards

Advancing Standards of Health and Safety

Chair Sweden SIS  
Wheelchair Seating Standards

Chair US ANSI/RESNA  
Wheelchair and Related Seating  
Standards. Experts in mult. wheelchair  
committees

Swedish and US Expert Representatives-  
ISO Wheelchair and Wheelchair Seating  
Stds Committee & others

Swedish rep and US ISO elected liaison to  
EU CEN Wheelchair Stds Committee

NPIAP Corporate Advisory Council;  
Support Surface Stds



ICS > 11 > 11.180 > 11.180.10

# ISO 16840-10:2021

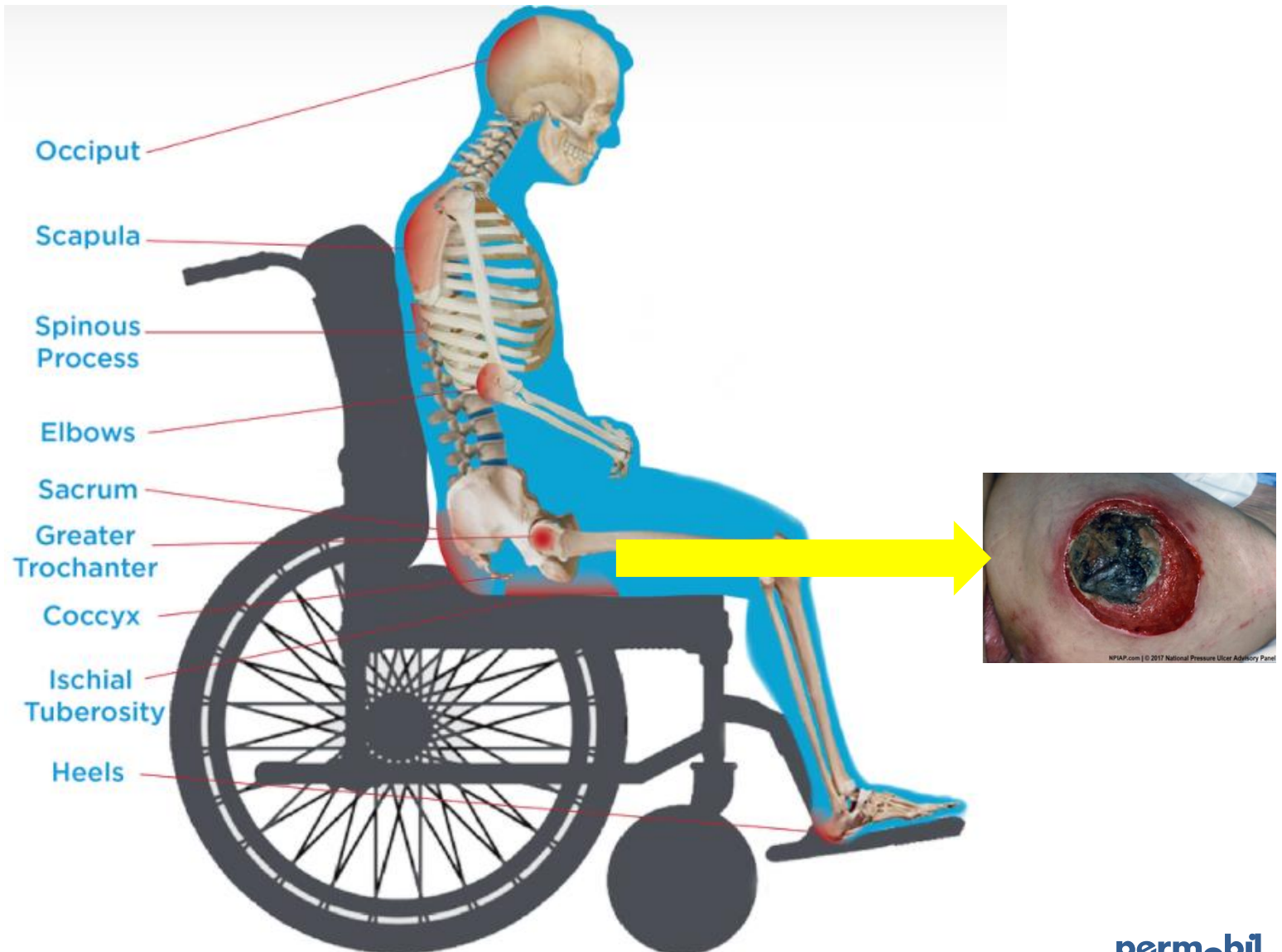
## Wheelchair seating — Part 10: Resistance to ignition of postural support devices — Requirements and test method



# Flammability Requirements Drive Design. Previous Restrictions:



# Wheelchair Seating has Clinical Benefits, Unlike Furniture



# What is safer / best for the wheelchair user?

## A risk management approach was taken, considering

- **Intended use** as a medical device (pressure injury prevention and positioning)
- Potential **compromise of function** (immersion and envelopment) when FR materials are employed
- Potential **health hazards** from flame retardants
- **Incidence rate** of fire/flame events and wheelchairs
- Global shift to remove flame retardants and open flame testing for furniture
- Pressure injury risk
- Overall benefits vs risk
  
- NOTE: from a lab perspective, an electronic ignition source is more controllable and repeatable than an open flame or cigarette

### Risk document available on ISO website

<https://committee.iso.org/sites/tc173/home/library.html>



# Flammability Risk Report Feb 2019

2/6/19 The ISO TC 173 committee for Assistive Products for Persons with Disabilities, specifically, subcommittee SC1 Wheelchairs, and Working Group WG 11 Wheelchair Seating, wish to inform you of the challenges to adoption of the flammability testing standard ISO 16840-10 in Europe. Thank you for your consideration as we collaborate with CEN on a path to European adoption of this clinically focused safety standard.

Kara Kopplin

ISO TC 173 / SC1 / WG 11 committee member, SC1 liaison to CEN  
Chair, RESNA Wheelchair and Related Seating Standards Committee (ANSI, USA)

## I. Introduction to ISO 16840-10

Wheelchairs -- Resistance to ignition of non-integrated seat and back support cushions

The committee TC 173 / SC / WG11 developed ISO 16840-10 after careful assessment of the potential risks and benefits that wheelchair seat and back cushions can provide an individual, as described in their "open letter on the use of cushion flammability standards". [1] The standard expresses this intention:

"The **tissue integrity devices** [see list item c]) are the subject of this part of ISO 16840, and permit a less stringent resistance to ignition than in ISO 7176-16, based upon the priority of these components for their **clinical function, which might override the need for a high resistance to ignitability**"

"c) devices to manage **tissue integrity**, such as seat and back support cushions which are intended to have **primarily a clinical function to minimize the risks of skin damage** (these may also be intended to control posture)"

## II. The Problem

Although ISO 16840-10 was published in 2014, specifically for clinical wheelchair seat and back cushion technologies, tender and registration bodies continue to request furniture flammability standards such as EN 1021-1 and EN 1021-2 in 2018, particularly through the more general requirements of EN 12182, EN 12183, and EN 12184.

The work of the WG11 committee, in writing this standard, has not yet benefited the users of wheelchairs as desired.

## III. Risk Considerations

In considering the intended clinical benefits of wheelchair seating, the associated risk from ignition sources, as well as unintended risks, the following are considered:

### A. Intended Use / Intended Function

- Wheelchair seat and back cushion design is critical to providing **skin/soft tissue protection**. ISO 16840-10 states "The intent of this part of ISO 16840 is primarily to cover removable cushions whose described purpose is that of **protecting skin tissue against pressure, shear, and maceration related damage**," which have been identified as key contributors to pressure injuries [2]

- Immersion and envelopment** are key design strategies to provide tissue protection. Per the National Pressure Ulcer Advisory [Panel](#), "Cushion construction achieves pressure redistribution in one of two basic methods: immersion/envelopment or redirection/off-loading" [2]
- Cover design is critical, as the NPUAP notes "select a pressure redistribution cushion that...has a **stretchable cover** that fits loosely on the top of cushion surface and is **capable of conforming to the body contours**" [2]
- Biocompatibility** is important for the end user, with ISO 16840-10 stating "Materials chosen are to comply also with biocompatibility requirements (ISO 10993-1 and ISO 10993-10)."

### B. Unintended Risks from Flame Retardants

- Stiffer Materials** are typically employed to achieve the flammability resistance of open flame, furniture standards, which can **limit the necessary immersion and envelopment** of the body in the cushion, thereby reducing the intended benefit and limiting efficacy.
- Stiffer Cover Materials**, in particular, do not allow for the recommended stretching and yielding to facilitate compliance of the cover and cushion combination with the body.
- Toxic chemicals**, as recognized in the European Union and/or other regions of the world, are often employed to provide the flame resistance.
  - In 2018 The State of California issued a regulatory amendment to eliminate the use of open flame standards for furniture in public buildings, because compliance to current open flame test TB 133 presents "**unnecessary health risks**", further stating "by **reducing the need for flame retardant chemicals**, this action is anticipated to **improve public health** by reducing exposure to carcinogenic organohalogen flame retardants" [3]
  - Jan 22, 2019 California's Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation (Bearhfti) **repealed Technical Bulletin (TB) 133 – The Flammability Test Procedure for Seating Furniture for Use in Public Occupancies**. Bearhfti said TB 133 has become "obsolete" in most areas, as it overlaps with the recently updated **TB 117-2013**. Furthermore, it said, the use of organohalogen flame retardants typically used to meet TB 133 "present significant health risks to consumers, as established by overwhelming scientific research. [4]"
  - In 2015 Minnesota legislators passed into law the "Firefighter and Children Health Protection Act" which **prohibits the sale and distribution of children's products and upholstered residential furniture** that contain more than a certain amount of one or more **flame retardant chemicals** named within the bill. [5]
  - The Minnesota research [4] examined numerous **flame retardant** chemicals, all of which are banned in the Cal Prop 65 list, and many are banned in the REACH Substances of Very High Concern (SVHC) list. The report cites evidence that flame retardants may present exposure and health concerns, including:
    - Crossing the placenta and passing through breast milk
    - Altering the endocrine system, causing fluctuations in thyroid production.
    - Altering sex hormones
    - Affecting the nervous system
    - Causing uterine tumors
    - Affecting reproductive health
    - Affecting early development
    - Causing cancer

# Flammability Risk Report Feb 2019

- **Harmful chemicals** can be released by ignition itself. ISO 16840-10 states "Good practice is also to use materials which **minimize the risk of release of toxic substances** as a result of ignition."

## Probability of Occurrence

- Ignition of wheelchair components is extremely low as evidenced by the FDA MAUDE database of reportable events [5]. There are an estimated 3.6 million US citizens who use wheelchairs [6], and events tagged as flammability occurrences accounted for less than one one-hundredth of a percent, with at least a third being unrelated/incorrectly tagged.
- Commercially available cigarettes now have a reduced ignition propensity (RIP). The WHO reports "adoption of the RIP standard by US appears to be the '**principal reason for a 30% decline in smoking material deaths** from 2003 to 2011...All 50 US States, Australia, Canada, Iceland, South Africa, and all 28 European Union Member States have adopted policies enforcing RIP cigarettes" [7]
- Smoking as an ignition source has decreased. Per the Centers for Disease Control "**cigarette smoking among U.S. adults (aged ≥18 years) declined from 20.9 percent in 2005 to 15.5 percent in 2016** [8]
- Unlike a mattress or couch, in a wheelchair seating system, the amount of **material that could be exposed to an ignition source is extremely low**, and many of those areas are vertical surfaces on which a flame or match could not rest.

## Overall Risk Management:

- Underwriters Laboratories commented upon the California regulations, which are used throughout the US: "environmental advocates, health professionals and academics, expressed concern about the use of FR chemicals in upholstered furniture. These concerns ultimately led to an executive order from the California Governor instructing the BHFTI to revise California TB 117 to **eliminate the need for FR chemicals in furniture sold in California, while at the same time not reducing the level of safety to the public.** [9]
- ISO 16840-10 "The day to day usage of a wheelchair may affect its materials' resistance to ignition...Different environments commonly encountered by some wheelchair occupants may also affect the flammability of materials... **Wheelchair manufacturers and occupants** should be aware of these risks, and **design and use wheelchairs accordingly** as covered by ISO 14971"
- ISO 16840-10 "Requirements for the control of risks from sources of fire created by **electrical and electronic components** are included in **ISO 7176-14**" Per the MAUDE database search, electrical sources accounted for the vast majority of the (extremely limited) flammability incidents, [5] so this risk is managed through the ISO 7176-14 standard.
- **MDR Regulation** (EU) 2017/745 All known **and foreseeable risks**, and any **undesirable side-effects**, shall be **minimised** and be acceptable when **weighed against the evaluated benefits to the patient and/or user** arising from the achieved performance of the device during normal conditions of use. [10]

## Standards

- EN 1021-1 Furniture – Assessment of the ignitability of upholstered furniture – Part 2: Ignition source smouldering cigarette
- EN 1021-2 Furniture – Assessment of the ignitability of upholstered furniture – Part 2: Ignition source match flame equivalent
- EN 12182 Assistive products for persons with disability – general requirements and test methods
- EN 12183 Manual Wheelchairs – Requirements and test methods
- EN 12184 Electrically powered wheelchairs, scooters, and their chargers. Requirements and test methods
- ISO 14971 Medical Devices – Application of risk management to medical devices
- ISO 16840-10 Wheelchairs - Resistance to ignition of non-integrated seat and back support cushions — Part 10: Req. and test methods
- ISO 7176-14 Wheelchairs-Part 14: Power and control systems for electrically powered wheelchairs and scooters – Req. and test methods
- ISO 7176-16 Wheelchairs — Part 16: Resistance to ignition of postural support devices

## Citations

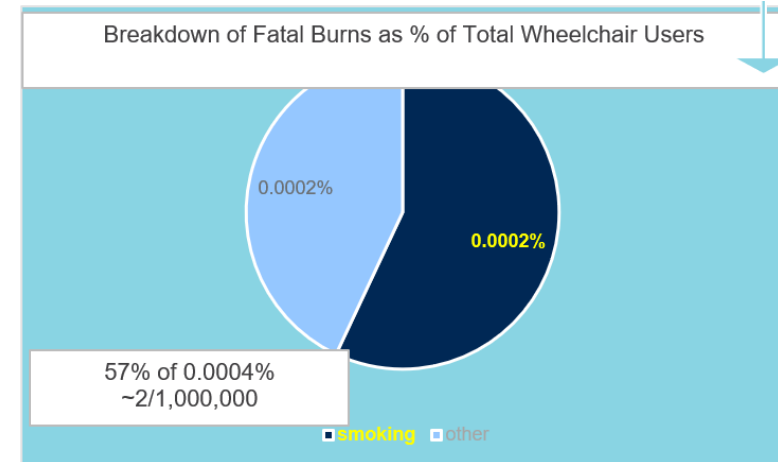
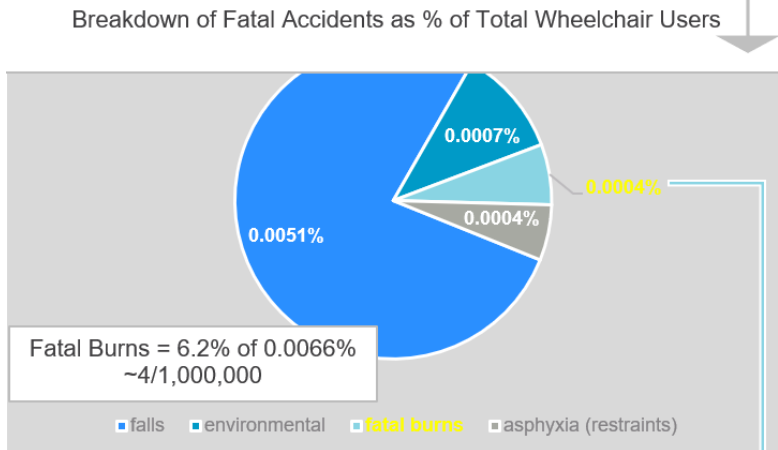
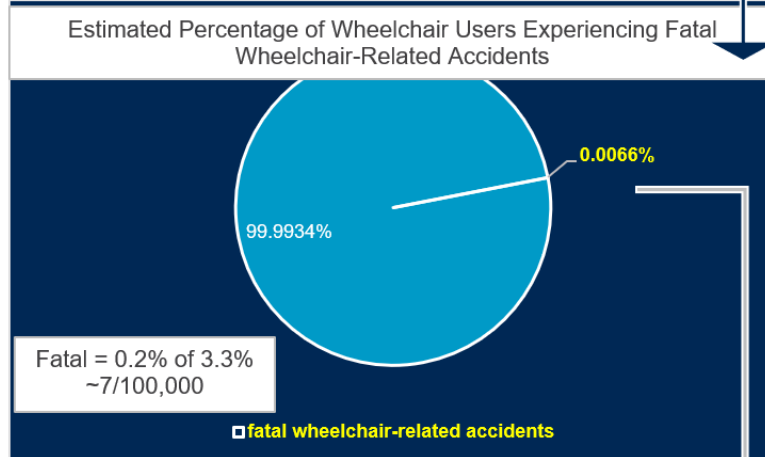
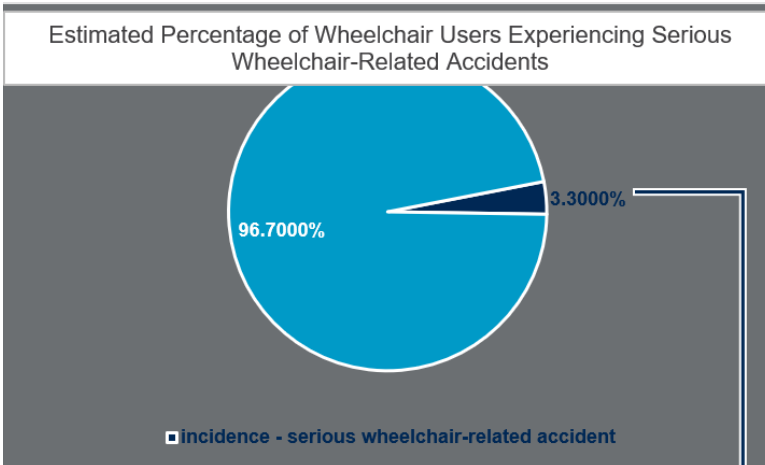
- [1] Open letter from ISO TC 173 / SC1 / WG11  
<https://isotc.iso.org/livelink/livelink?func=ll&objid=16468463&objAction=browse&viewType=1>
- [2] National Pressure Ulcer Advisory Panel (NPUAP), European Pressure Ulcer Advisory Panel (EPUAP) and Pan Pacific Pressure Injury Alliance (PPPIA) "Prevention and treatment of pressure ulcers: clinical practice guideline." (2014). <http://www.npuap.org/national-pressure-ulcer-advisory-panel-npuap-announces-a-change-in-terminology-from-pressure-ulcer-to-pressure-injury-and-updates-the-stages-of-pressure-injury/>
- [3] July 27, 2018 State of California – California Regulatory Notice Register TITLE 4. BUREAU OF ELECTRONIC AND APPLIANCE REPAIR, HOME FURNISHINGS, AND THERMAL INSULATION Amendment of Flammability Standards — Notice File No. Z2018-0713-01.  
<https://oal.ca.gov/wp-content/uploads/sites/166/2018/07/30r-2018.pdf>
- [4] TB 133 has been repealed by California's Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation, effective January 22, 2019  
<https://www.sgs.com/en/news/2019/02/safeguards-02019-california-technical-bulletin-133-flammability-test-for-seating-furniture>
- [5] 2015 Minnesota - "Firefighter and Children Health Protection Act" (Minn. Stat. 2015 325F.071)  
<http://www.health.state.mn.us/diws/eh/risk/studies/retardantreport.pdf>
- [6] U.S. FDA MAUDE database frequency of occurrence – medical device reports submitted to the FDA by mandatory reporters – (manufacturers, importers and device user facilities) and voluntary reporters such as health care professionals, patients and consumers.  
<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfmaude/search.cfm>
- [7] U.S. Disability Statistics and Information, 2013-05-29 (Rev. 2013-07-10) US Census Bureau  
<https://www.disabled-world.com/disability/statistics/info.php>
- [8] World Health Organization report on RIP cigarettes  
[https://www.who.int/tobacco/industry/product\\_regulation/factsheetreducedignitionpropensitycigarettes/en/](https://www.who.int/tobacco/industry/product_regulation/factsheetreducedignitionpropensitycigarettes/en/)
- [9] Centers for Disease Control and Prevention  
[https://www.cdc.gov/tobacco/data\\_statistics/fact\\_sheets/fast\\_facts/index.htm](https://www.cdc.gov/tobacco/data_statistics/fact_sheets/fast_facts/index.htm)
- [10] 2014 UL Report Understanding the Changes to California TB 117 – 2013  
[https://industries.ul.com/wp-content/uploads/sites/2/2014/10/TB-117\\_Article.pdf](https://industries.ul.com/wp-content/uploads/sites/2/2014/10/TB-117_Article.pdf)
- [11] Annex 1 General Safety and Performance Requirements MDR Regulation (EU) 2017/745 <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R0745>

5/19 Update– Given the minimal risks of flammability as a hazard in wheelchair seating, and the significant potential health effects of flame retardants, strong consideration should be given to utilizing ISO 16840-10 as a ignition resistance standard for all wheelchair seating textiles / soft components (not just tissue integrity components). Eliminating the extreme flame resistance required for ISO 7176-16 compliance would allow more rationally appropriate textiles to be used, for the health and comfort of the wheelchair user.



Q: What is the Fire Fatality rate?

A: <4 per million



Calder, J., and Kirby, L. (1990). "Fatal Wheelchair-related Accidents in the United States." *American Journal of Physical Medicine & Rehabilitation*. 69(4): 184-190.

**Q: What is the Pressure Injury Fatality Rate? A: 60,000/yr in US alone**



Dr. Padula's report to US Congress: *Value of hospital resources for effective pressure injury prevention: a cost-effectiveness analysis:*

**“pressure injuries affect 2.5 million patients, resulting in 60,000 deaths and over \$26 billion in U.S. healthcare expenditures”** *per year*

# Wheelchair Flammability Standards Advanced

## 2014 Document Revised in 2021

- Wiring details clarified/corrected
- Scope expanded to be applicable to all wheelchair support surfaces
- ISO 7176-16 (open flame test for wheelchairs) replaced by ISO 16840-10:2021
- Opportunity to use other ignition sources (that achieve the temperature profile) were noted
- Standard allows NO flaming, as opposed to 2 min of flaming in other standards

**Committee recommendation of ISO 16840-10 available on ISO website:**

<https://committee.iso.org/sites/tc173/home/library.html>

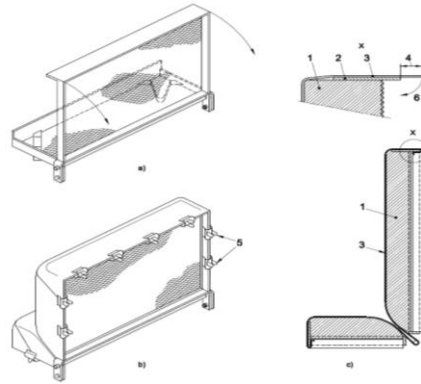


# Furniture vs Wheelchair Seating Flammability Standards

## EN 1021-2 Open Flame

*Furniture – Assessment of the ignitability of upholstered furniture. Part 2: Ignition source match flame equivalent*

Test construction is unlike wheelchair. Small PSDs and pediatric devices may be excluded



15 sec flame applied (no temp given, butane, difficult to control)

**Flaming ALLOWED for 120 sec after source removed.**  
**Progressive smouldering allowed for 1 hr (3600 sec).**

### 3.2 Flaming ignition

#### 3.2 Flaming ignition

For the purposes of this European Standard, all the following types of behaviour are considered to be flaming ignitions:

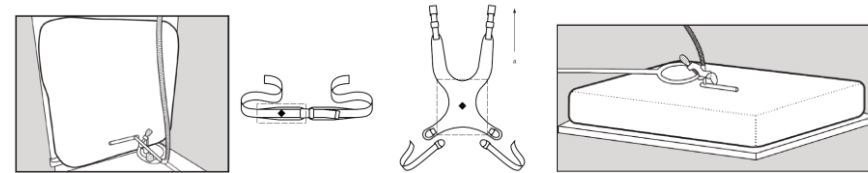
- any test assembly that displays escalating combustion behaviour so that it is unsafe to continue the test and active extinction is necessary;
- any test assembly that burns until it is essentially consumed within the test duration;
- any test assembly on which any flame front reaches the lower margin, either side or passes through its full thickness within the duration of the test;
- any flaming which continues for more than 120 s after removal of the burner tube.

**Tests time for flame to self extinguish**

## ISO 16840-10 Electronic Ignition Source

*Wheelchair Seating — Part 10: Resistance to ignition of postural support devices — Requirements and test methods*

Test applied to wheelchair PSDs, horizontal or vert. surfaces, including small PSDs and pediatric devices



60 sec 575 C controllable, repeatable ignition source applied

**NO flaming is allowed.**  
**Progressive smouldering allowed for 120 sec. (12/21 correction)**

### 8 Requirements

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

- show no evidence of flaming in the interior and/or surface during or after the test, and
- show no evidence of progressive smouldering 20 s ± 1 s after the end of the maximum temperature plateau of the temperature heating curve.

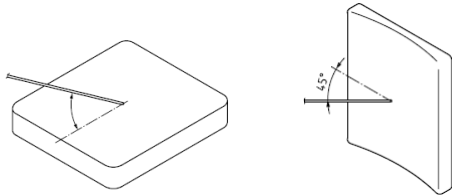
**Tests resistance to ignition / flame**

# ISO 7176 vs ISO 16840 Wheelchair Seating Flammability Standards

## ISO 7176-16 Open Flame

*Wheelchairs – Part 16: Resistance to ignition of postural support devices (replaced by ISO 16840-10)*

Test applied to wheelchair PSDs, horizontal or vert. surfaces.  
Does not cover small PSDs and pediatric devices



20 sec flame applied (no temp given, butane, difficult to control)

**Flaming is ALLOWED for 120 sec** after source removed as well as afterglow, smoking, smouldering.

Burn area <math><600 \text{ mm}^2</math> (horizontal) or <math><4500 \text{ mm}^2</math> (vertical),

8.1 Following the test procedure specified in Clause 7, all postural support devices of the wheelchair shall:

- show no evidence of progressive smouldering or flaming in the interior and/or surface after 120 s after removal of the ignition source;
- exhibit no burn damage area greater than  $600 \text{ mm}^2$  of any layer when tested in a horizontal orientation;
- exhibit no burn damage area of any layer greater than  $4\,500 \text{ mm}^2$  when tested in a vertical orientation.

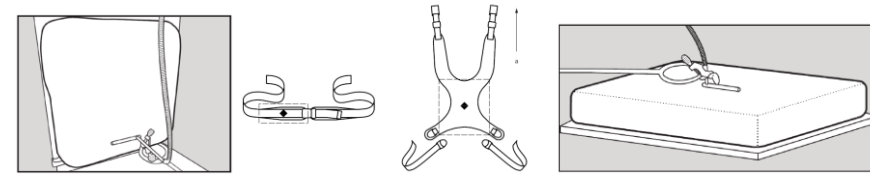
8.2 Burn damage shall include discolouration but shall exclude discolouration caused by deposition of smoke particles.

**Tests time for flame to self extinguish**

## ISO 16840-10 Electronic Ignition Source

*Wheelchair Seating — Part 10: Resistance to ignition of postural support devices — Requirements and test methods*

Test applied to wheelchair PSDs, horizontal or vert. surfaces, including small PSDs and pediatric devices



60 sec 575 C controllable, repeatable ignition source applied

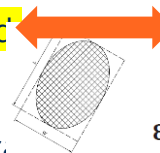
**NO flaming is allowed.**  
Progressive smouldering allowed for 120 sec. (12/21 correction)

### 8 Requirements

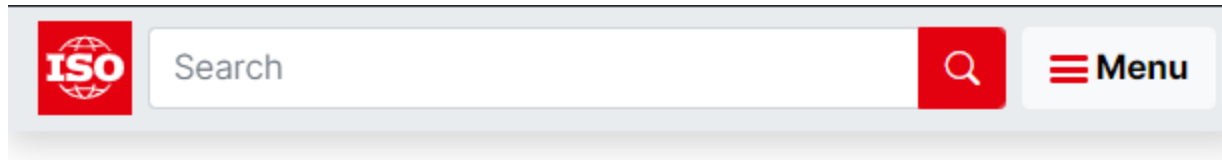
In horizontal and vertical orientations, when subjected to the heat source specified in 6.4, PSDs used in a wheelchair shall

- show no evidence of flaming in the interior and/or surface during or after the test, and
- show no evidence of progressive smouldering  $20 \text{ s} \pm 1 \text{ s}$  after the end of the maximum temperature plateau of the temperature heating curve.

**Tests resistance to ignition / flame**



# ISO 7176-16 Obsolete



← ICS ← 11 ← 11.180 ← 11.180.10

## ISO 7176-16:2012

Wheelchairs — Part 16: Resistance to ignition of postural support devices

This standard has been revised by ISO 16840-10:2021



# European Standards and MDR



EUROPEAN INNOVATION PARTNERSHIP  
on Active and Healthy Ageing

European Commission > EIP on AHA > Standards > Healthcare > Personal autonomy > EN 12183:2014

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## EN 12183:2014

**Subject:**  
Healthcare

**Sub-subject:**  
Personal autonomy

**Reference:**  
EN 12183:2014

**Title:**  
Manual wheelchairs - Requirements and test methods

**Kind of resource:**  
Standard

**Year of publication:**  
2014

**URL:**  
[http://standards.cen.eu/dyn/www/f?p=204%3A110%3A0%3A%3A%3A%3AFSP\\_PROJECT%2CFSP\\_O...](http://standards.cen.eu/dyn/www/f?p=204%3A110%3A0%3A%3A%3A%3AFSP_PROJECT%2CFSP_O...)

**Description:**  
This European Standard specifies requirements and test methods for manual wheelchairs intended to carry one person of mass not greater than 250 kg. It also specifies requirements and test methods for manual wheelchairs with electrically powered ancillary equipment. This European Standard does not apply in total to: - wheelchairs intended for special purposes, such as sports, showering or toileting, - manual wheelchairs with handrim-activated power-assisted propulsion, - custom-made wheelchairs, - stand-up wheelchairs, and - manual wheelchairs with add-on power kits used for propulsion. NOTE Requirements for electrically powered wheelchairs are specified in EN 12184.



EUROPEAN INNOVATION PARTNERSHIP  
on Active and Healthy Ageing

European Commission > EIP on AHA > Standards > Healthcare > Personal autonomy > EN 12184:2014

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## EN 12184:2014

**Subject:**  
Healthcare

**Sub-subject:**  
Personal autonomy

**Reference:**  
EN 12184:2014

**Title:**  
Electrically powered wheelchairs, scooters and their chargers - Requirements and test methods

**Kind of resource:**  
Standard

**Year of publication:**  
2014

**URL:**  
[http://standards.cen.eu/dyn/www/f?p=204%3A110%3A0%3A%3A%3A%3AFSP\\_PROJECT%2CFSP\\_O...](http://standards.cen.eu/dyn/www/f?p=204%3A110%3A0%3A%3A%3A%3AFSP_PROJECT%2CFSP_O...)

**Description:**  
This European Standard specifies requirements and test methods for electrically powered wheelchairs, including electrically powered scooters with three or more wheels, with a maximum speed not exceeding 15 km/h intended to carry one person of mass not greater than 300 kg. It also specifies requirements and test methods for battery chargers for wheelchairs and scooters. This European Standard does not apply in total to: - electrically powered wheelchairs intended for special purposes, such as sports, showering or toileting, - manual wheelchairs with handrim-activated power-assisted propulsion, - custom-made electrically powered wheelchairs, - electrically powered stand-up wheelchairs, - manual wheelchairs with add-on power kits used for propulsion and - electrically powered office chairs. NOTE Requirements for manually propelled wheelchairs are specified in EN 12183.



# Publication – CEN EN 12183, EN 12184 including ISO 16840-10

## ATSC Wheelchair & Related Seating

[Post New Message](#)

[European Wheelchair Standards to Include ISO 16840-3 and ISO 16840-10](#)

[Reply to Group](#)

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Jul 19, 2022 3:37 PM

[Kara Kopplin](#)

Dear WRS Committee Members:

On July 12, 2022, we received word that the updated European test standards for manual and power wheelchairs, EN 12183 and EN 12184, completed EU voting and were accepted for publication. ISO 16840-3 is noted in the static, impact, and fatigue testing section, and ISO 16840-10 is the preferred and referee flammability test method. It is exciting to have our international seating standards included within these EU wheelchair standards, for the very first time!

Thank you to all of you for your ongoing support developing and promoting seating standards which are critical to the health, safety, and independence of wheelchair users. Your work matters and is appreciated.



## EN 12184:2022 (E)

### 9.5 Resistance to ignition

#### 9.5.1 General

The surfaces of components which support the occupant, or which stay in contact with the occupant or the occupant's clothing, shall be tested as specified in 9.5.2. Progressive smouldering ignition or flaming ignition as defined in the standard applied shall not occur.

This requirement does not apply to components of the power and control system, which are covered by 9.5.3.

It is not necessary to test components that are inherently resistant to ignition, e.g. steel frame tube.

NOTE ISO 7176-19 provides related requirements for belt-type restraints. See 8.3.

#### 9.5.2 Test methods

##### 9.5.2.1 Selection of test method

The test method specified in 9.5.2.2 is the preferred test method. It is the referee test method, which is used to resolve doubts or dispute.

The test methods specified in 9.5.2.3 may be used as alternatives.

##### 9.5.2.2 Referee test method

Select and test a sample of the component as specified in ISO 16840-10:2021.

NOTE The introduction to ISO 16840-10:2021 provides a rationale for use of the test method.

##### 9.5.2.3 Alternative test methods

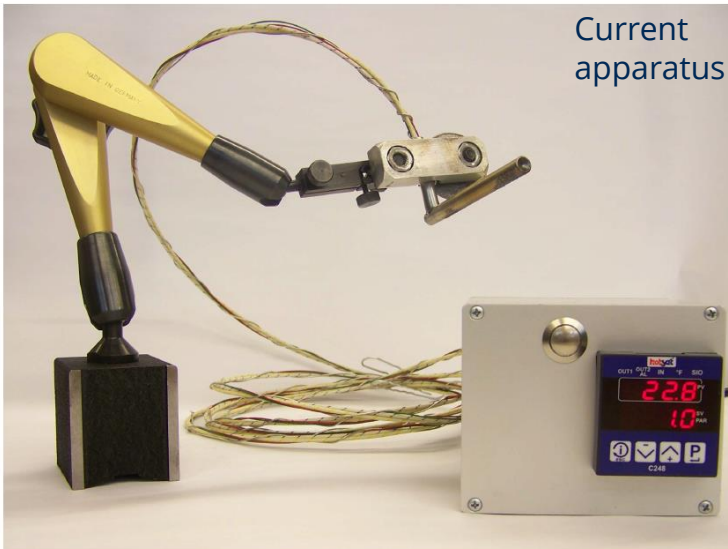
Test the material of each component in accordance with EN 1021-2:2014 or ISO 8191-2:1988.



ICS > 11 > 11.180 > 11.180.10

# ISO 16840-10:2021

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



# Validation of Reliable Hot Wire Method

## 2021 Document Allows:

**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.

- **Committee members had developed a coil hot wire alternative**
  - **Low cost**
  - **Readily available components**
  - **Ease of setup and use**
- **Verification of temperature output and validation to a cigarette burn confirmed within development lab at Bodypoint**
- **Inter-laboratory testing needed**
- **Testing conducted across 5 labs, with identical apparatus and methods, throughout 2022**

# Correlation of Temperatures to Amperage to Cigarette

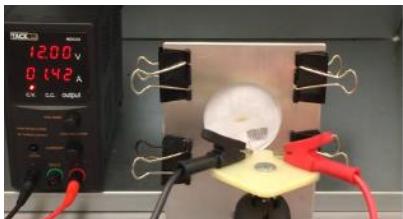
Wire Amperage (Temp)

2.5 amps (593)

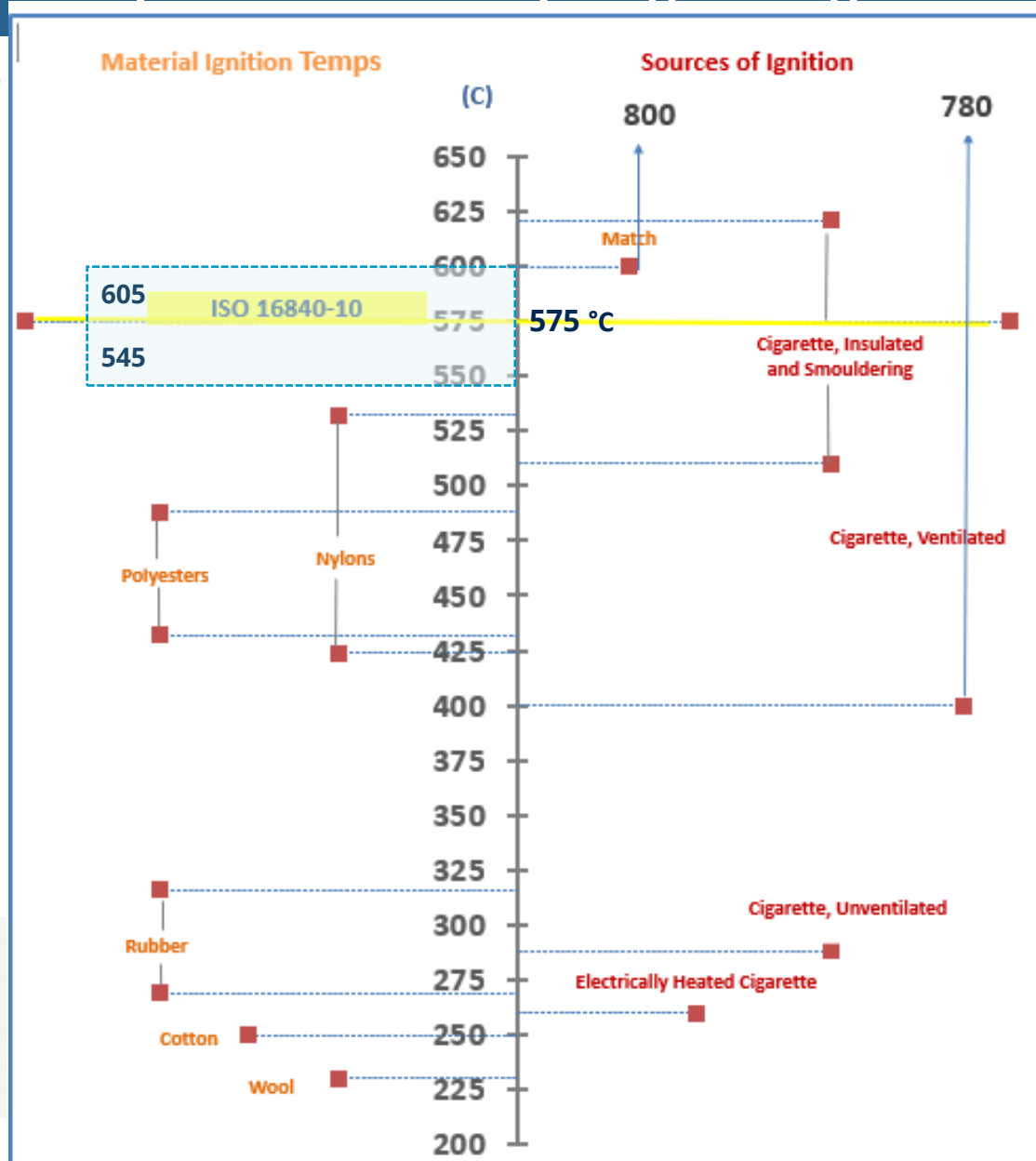
2.0 amps (538)



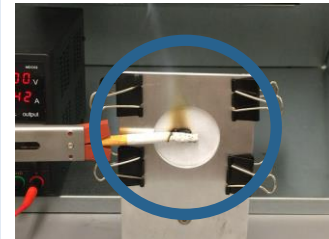
1.42 amps (316)



23 Confidential



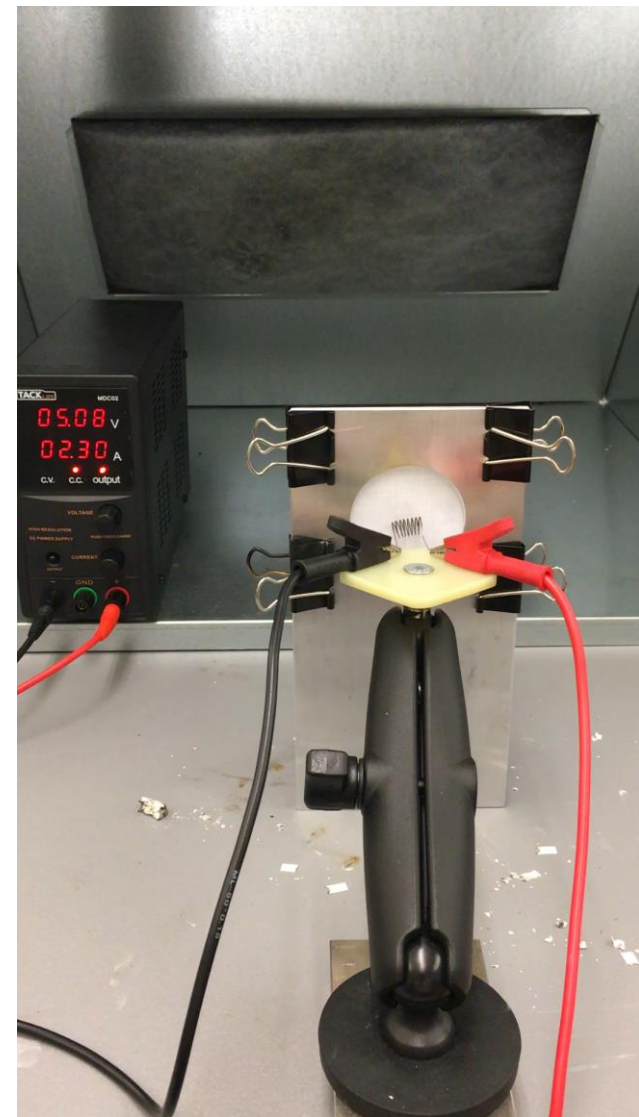
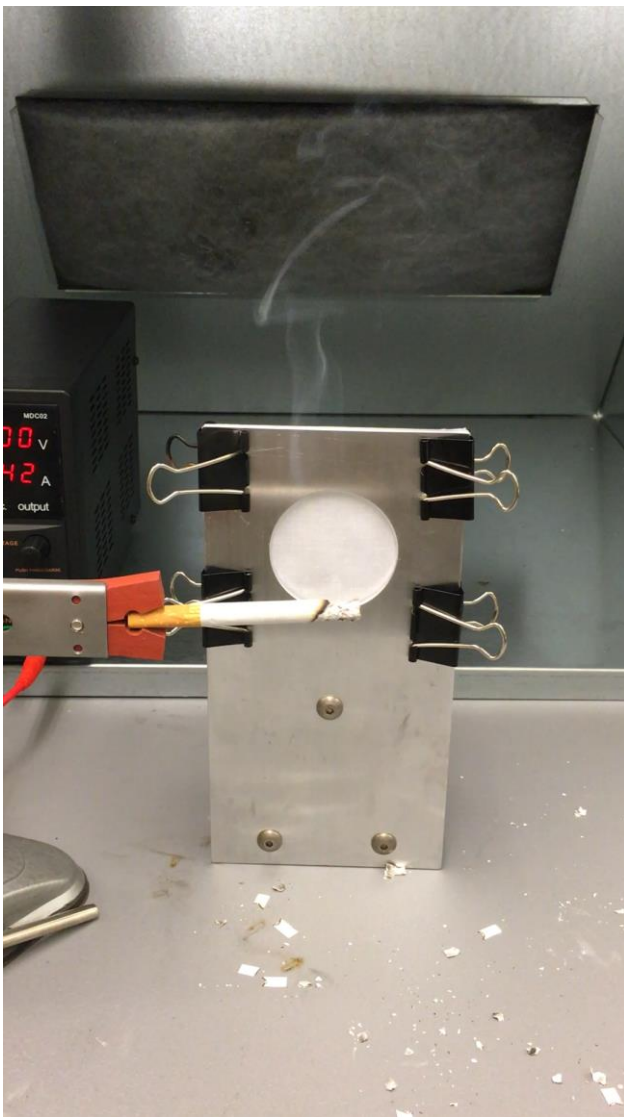
Real Cigarette



permobil



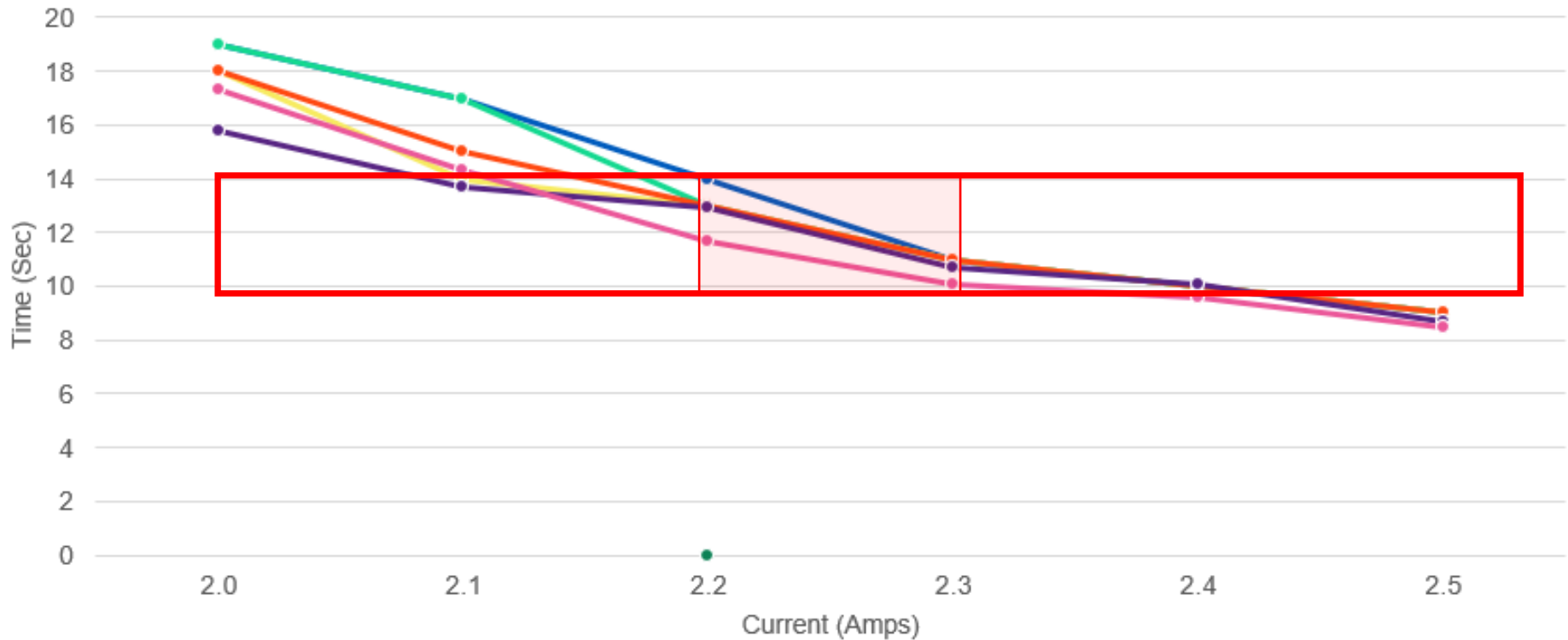
# Cigarette, Paper Ignition, and Wire Amperage Correlation



# Interlaboratory Test Results – Paper Strip Calibration

## Time for Paper to Ignite vs. Current Settings

EC1 EC2 EI1 EI2 BP1 BP2



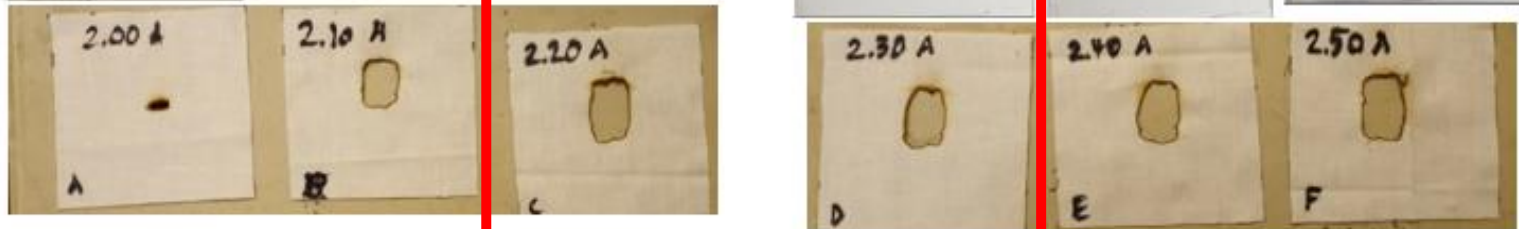
Paper burning withing 10-14 seconds correlates to  
2.2 – 2.3 amps, center of range

# Interlaboratory Test Results

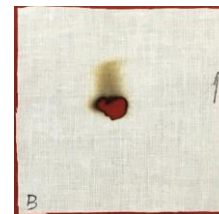
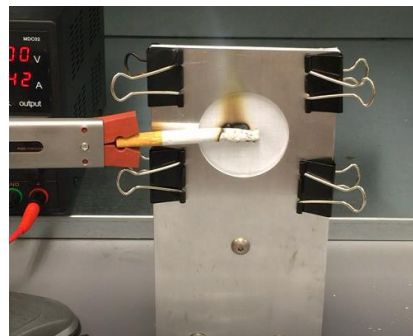
EC Service



Element



Bodypoint



Recommendation to WG11:  
Hot Wire apparatus preferred. Calibration with paper burn of 10-14 seconds

# Recommendation to WG11 and International Ballot

## Annex to Detail Hot Wire build and Method

- Working Group secretary and convenor recommended updates be drafted based on inter-lab results. Work began at ESS in Dublin June '22
- Draft including detailed components lists, precise build instructions, and refined method presented at WG11 standards meeting in Berlin Oct '22. Group approved proceeding with Annex
- Document submitted to ISO secretariat 12/10/22 for balloting

# Annex includes full details for Hot Wire Build

ISO CD 10849-2021/Annex D (2023) (E)

Annex D  
(Normative) Test method using a NiCr wire coil as a heat source

**A.1 Principle**  
A NiCr wire coil heat source as described in this Annex has been developed and validated to approximate the heat output and thermal mass of a heating element as determined by observing the ignition behavior and resulting burn patterns from a variety of specimens. The responsibility of the ignition behavior and resulting burn patterns from the device has been validated through interlaboratory testing (IL).

**A.2 Test environment**  
The test environment shall have a temperature of 23°C ± 2°C and a relative humidity of 50% ± 20%.

**A.3 Test enclosure**  
To the protection of the lab technician the test enclosure shall consist of either a room or a smaller enclosure designed to contain smoke and fumes. In absence of such conditions, the technician shall use other precautions against smoke inhalation. The room shall be capable of containing the heat in the range of 0.1 m<sup>3</sup> to 0.2 m<sup>3</sup>.

**A.4 Test apparatus**  
The test apparatus shall be a heat source that consists of a wire coil of NiCr alloy resistance wire, heated by a DC power supply that has a constant current output mode.

**A.4.1 Wire coil**  
The wire coil shall be made from an alloy of 80% nickel, 10% chromium, and 20% iron (known as "Nichrome 80" or "Chromal 80"). The diameter of the wire shall be 0.75 mm (0.030 in) (formerly 0.8 mm ± 0.005).  
NOTE 1: Resistance 10 to 100 ohms may be substituted, as the power supply calibration will account for coil ohmic resistance.  
The wire shall be second to produce a wire coil with the specifications shown in Figure D.1.  
NOTE 2: A method for winding the wire coil to these specifications is provided in Annex E.

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ISO CD 10849-2021/Annex D (2023) (E)

**D.1.1 Dimensions of wire coil**

**D.1.2 Power supply and connection to the wire coil**  
The power supply shall be capable of producing a constant current between 1 and 5 A with adjustments in 0.5 A increments. The wire coil shall be connected to the power supply by a means to ensure good electrical conductivity.  
NOTE 1: Crocodile (alligator) clips or high temperature silicone conductive wire leads are an effective means of connection.  
NOTE 2: Setting the current to the wire coil 2 mm from the crocodile clips results in a predictable length of wire through which the current flows actively. This shall provide calibration by paper strip ignition at approximately 2.2 to 2.3 A.

**D.1.3 Conditioning the wire coil**  
Before the wire coil can be used for testing, it shall be conditioned for use to reduce stress from the winding process and burn off any residual oil. To condition the wire, set the power supply to a constant current set to 1.7 V (for maximum power) and adjust the current to 4 for 10 to 15 s.  
NOTE: The wire coil will glow red hot, and after cooling, examine the middle of the wire coil to look for 10 to 15 mm, with no significant change to the diameter.

**D.1.4 Paper collection strip**  
A paper collection strip shall be made from 80 g/m<sup>2</sup> white bond paper cut to 5 mm ± 1 mm, 40 mm ± 5 mm and folded, as shown in Figure D.2.  
NOTE: The paper is equivalent to 100 gsm.

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ISO CD 10849-2021/Annex D (2023) (E)

**D.2 Paper collection strip, folded in half**

**D.2.1 Conditioning the wire coil**  
Before the wire coil can be used for testing, it shall be conditioned for use to reduce stress from the winding process and burn off any residual oil. To condition the wire, set the power supply to a constant current set to 1.7 V (for maximum power) and adjust the current to 4 for 10 to 15 s.  
NOTE: The wire coil will glow red hot, and after cooling, examine the middle of the wire coil to look for 10 to 15 mm, with no significant change to the diameter.

**D.2.2 Horizontal test**  
Set up the test sample in the same location used for calibration of the wire coil. The test sample shall be positioned such that the surface to be tested is horizontal (37°). A suitable wire clip may be used to hold the test sample in position.

**D.2.3 Vertical test**  
Set up the test sample in the same location used for calibration of the wire coil. The test sample shall be positioned such that the surface to be tested is vertical (37°). A suitable wire clip may be used to hold the test sample in position.

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**D.3 Heat source calibration**  
Calibration is required after conditioning a new wire coil, or if any other changes have been made to the connection or power supply. Calibration shall be done with the wire coil placed in the position which will be used for subsequent testing to ensure effects of air flow passing over the heat source are consistent. Calibration shall be conducted without a test sample in place, in the presence of a test sample can affect the heat surface accessible wire coil.  
The following process shall be followed:  
a) Place a folded paper collection strip between middle coils (Figure D.3), with the power turned off (note).  
b) Place the wire coil with the test sample.

**D.3.1 Apparatus**  
a) Identify the PDS.  
b) Select the surface(s) that the manufacturer assumes to be at risk from the source (see Annex D). These shall be identified as the test surface.  
c) If testing from an area intended to be used only in the range of the horizontal plane (37°), use the horizontal test, and in all other respects, use the vertical test. If the part is intended for use in other planes, then only the vertical test is necessary.  
d) Place the test sample in the test enclosure for a minimum of 12 h in condition to be tested.

**D.3.2 Horizontal test**  
Set up the test sample in the same location used for calibration of the wire coil. The test sample shall be positioned such that the surface to be tested is horizontal (37°). A suitable wire clip may be used to hold the test sample in position.

**D.3.3 Vertical test**  
Set up the test sample in the same location used for calibration of the wire coil. The test sample shall be positioned such that the surface to be tested is vertical (37°). A suitable wire clip may be used to hold the test sample in position.

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**D.3.4 Placement position of wire coil heat source on a horizontal surface**  
Apply the ends of the wire coil to the test surface, pressing lightly, with some visible deflection of the surface. (see Figure D.3).

**D.3.5 Test procedure**  
a) Photograph the sample, with the wire coil in position, prior to testing.  
b) Switch on the power to heat the wire coil for 10 ± 1 s. Observe the subsequent progress of ignition and record any flaming that occurs. Remove the heat source at the end of 10 s. Record any evidence of smouldering that continues after an additional 120 s.  
c) Photograph the sample, with the wire coil removed, to record results.  
d) Clean wire coil per Clause D.6.  
e) Repeat D.3.2 a) to f) from an unclassified area of the same test surface, for a total of two tests. If there is any flame or smouldering that continues after a second test on the same surface, a new sample shall be used and included in the test report.  
f) If the manufacturer has determined more than one surface to be at risk, repeat D.3.2 a) to f) on each surface to be tested.  
NOTE 1: If flaming occurs in the interior and/or surface during the test, the sample has failed.  
NOTE 2: Testing from a region and/or surface protected by reflecting them with a tapered cover to prevent the heat from affecting the test enclosure.

**D.3.6 Vertical test**  
a) Set up the test sample in the same location used for calibration of the wire coil. The test sample shall be positioned such that the surface to be tested is vertical (37°). A suitable wire clip may be used to hold the test sample in position.

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**D.4 Placement position of wire coil heat source on a vertical surface**

**D.4.1 Test procedure**  
a) Apply the ends of the wire coil to the test surface, pressing lightly, with some visible deflection of the surface. (see Figure D.4).  
b) Switch on the power to heat the wire coil for 10 ± 1 s. Observe the subsequent progress of ignition and record any flaming that occurs. Remove the heat source at the end of 10 s. Record any evidence of smouldering that continues after an additional 120 s.  
c) Photograph the sample, with the wire coil in position, prior to testing.  
d) Switch on the power to heat the wire coil for 10 ± 1 s. Observe the subsequent progress of ignition and record any flaming that occurs. Remove the heat source at the end of 10 s. Record any evidence of smouldering that continues after an additional 120 s.  
e) Photograph the sample, with the wire coil removed, to record results.  
f) Clean wire coil per Clause D.6.  
g) Repeat D.3.2 a) to f) from an unclassified area of the same test surface, for a total of two tests. If there is any flame or smouldering that continues after a second test on the same surface, a new sample shall be used and included in the test report.  
h) If the manufacturer has determined more than one surface to be at risk, repeat D.3.2 a) to g) on each surface to be tested.  
NOTE 1: If flaming occurs in the interior and/or surface during the test, the sample has failed.  
NOTE 2: Testing from a region and/or surface protected by reflecting them with a tapered cover to prevent the heat from affecting the test enclosure.

**D.5 Requirements**  
NOTE: An impact template which can be used to ensure this Annex is provided in Annex F.

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ISO CD 10849-2021/Annex E (2023) (E)

**Annex E**  
(informative)

**Guidance on fabrication of NiCr wire coil test apparatus**

Annex E provides practical guidance on procurement of and building a test apparatus suitable for application for carrying the test methods in Annex D.

**E.1 Apparatus**

Item No.	Element	Description
<b>Power supply/thermal</b>		
1	Resistance wire	Alloy of 80% nickel, 10% chromium, and 20% iron. Known as "Nichrome 80" or "Chromal 80". The diameter of the wire is 0.75 mm ± 0.005 (0.030 in) (formerly 0.8 mm ± 0.005).
2	Test leads	Wire leads with crocodile (alligator) clips for gripping wire coil
3	Mounting plate	Heat resistant base to secure crocodile (alligator) clips at fixed spacing
4	DC power supply (PS)	Must have "constant current" output mode. Its controlling the current out for high efforts of small variations in resistance between coils and regulated constant current are adequate.
<b>Coil holder (adjustable size) (Figure E.1)</b>		
5	Aluminum die-cast	Aluminum die-cast (or heavy-duty injection mold) of 23mm (0.91 in) (IP68) (IP68) (IP68)
6	Base Mount (die-cast)	Base Mount (die-cast) (aluminum) size 8 (8.089 x 6.210 in)
7	Heat Shield (die-cast)	Heat Shield (die-cast) (aluminum) size 8 (8.089 x 6.210 in)
8	Wire coil holder	Wire coil holder (die-cast) (aluminum) size 8 (8.089 x 6.210 in)

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ISO CD 10849-2021/Annex E (2023) (E)

**Annex E**  
(informative)

**Guidance on fabrication of NiCr wire coil test apparatus**

Annex E provides practical guidance on procurement of and building a test apparatus suitable for application for carrying the test methods in Annex D.

**E.1 Apparatus**

**E.1.1 Apparatus**

**E.1.2 Example apparatus**

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**E.2 Heat source construction**  
The heat source is to be constructed using the resistance wire specified in Annex D and Annex E.1. The "wire coil holder" components shown in Table E.1 and Figure E.1 can be used as wire winding tool.

**E.2.1 Preparation of wire winding tool**  
Machine M10 to remove residual "oil-leaking" "lip" that obstructs the wire when second round on M10 screw (see Figures A.3 and A.4).

**E.2.2 Preparation of wire winding tool**

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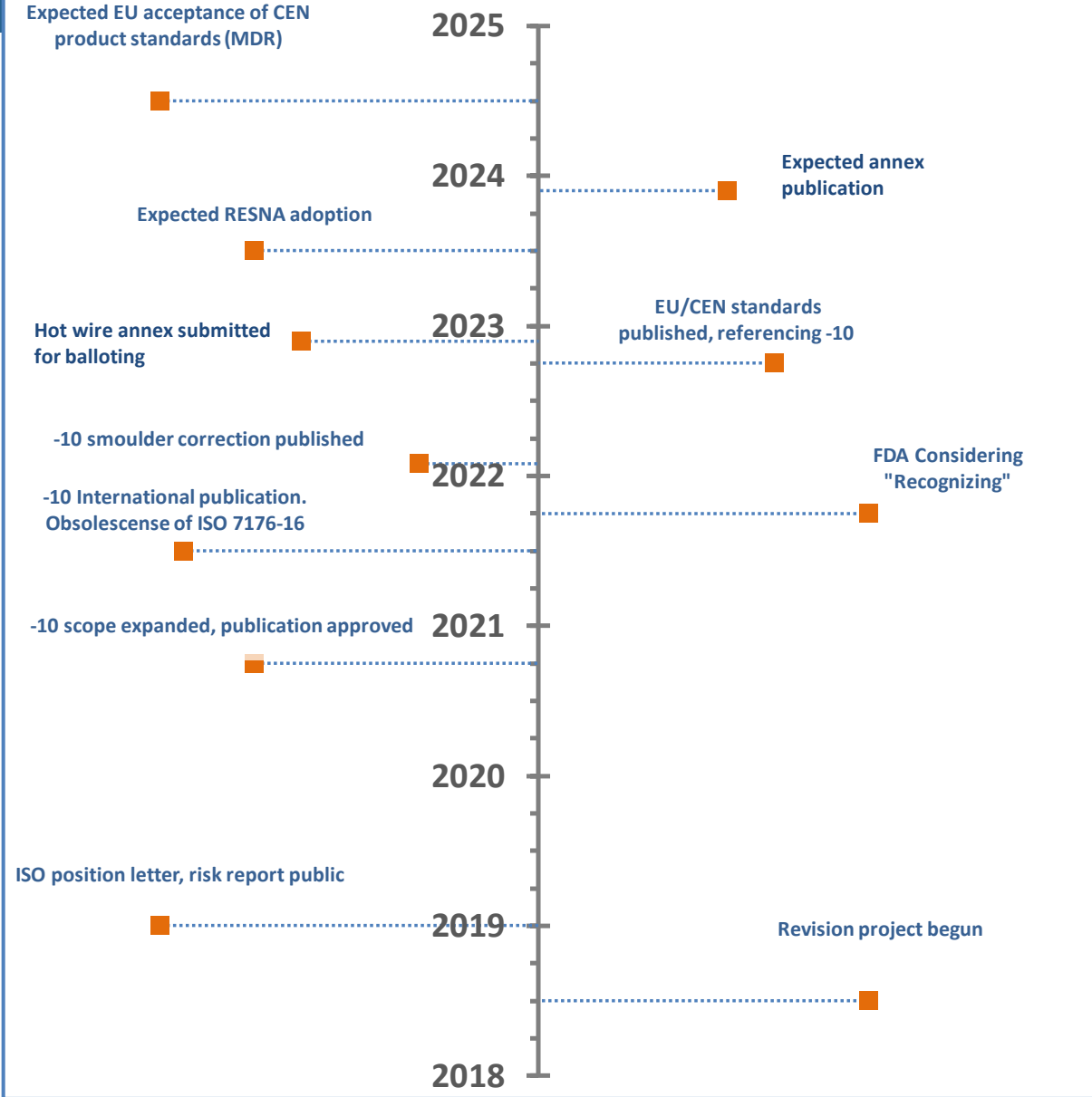
**E.2 Heat source construction**  
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**E.2.1 Preparation of wire winding tool**  
Machine M10 to remove residual "oil-leaking" "lip" that obstructs the wire when second round on M10 screw (see Figures A.3 and A.4).

**E.2.2 Preparation of wire winding tool**

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# New Wheelchair Flammability Standard: ISO 16840-10:2021





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Wheelchair and Related Seating

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