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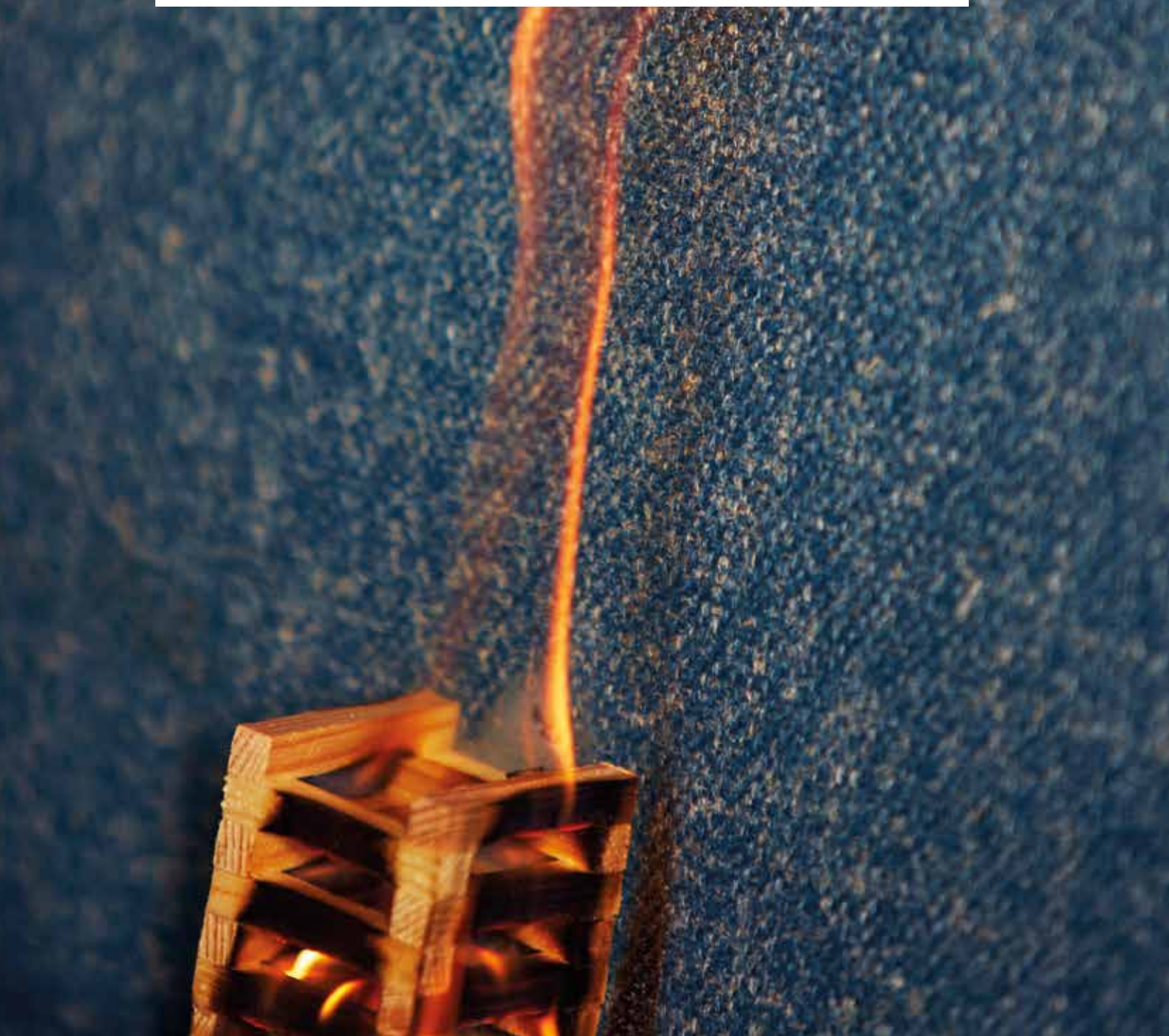
Global flammability standards.

A Camira Technical Paper

A resource examining flame retardancy testing of contract textiles and factors affecting flammability performance.



Flammability performance

Fire safety is the most significant technical requirement of an interior textile. Fabrics that perform well in potentially dangerous situations can help to ensure that buildings and interiors are safe places to work, socialise and live. But it's not always that simple and there are many elements that play a part in fire security, not least the vast array of international flammability standards and test methods which apply in different parts of the world in the contract interiors sector.

This paper covers the different requirements and approaches in the main global regions.

Cover: A Crib 5 burning on the test rig, during the BS 5852 Medium Hazard test.

How flame retardancy works

In order for a material to burn, three essential inputs are required: fuel, heat and oxygen. Break this cycle and you're well on the way to achieving flame retardancy within a fabric and increasing the length of time it takes to burn.

The fuel element is the textile in question and any interior fixture/fitting with the potential to burn. The heat is energy from the ignition source which can be in the form of either a flame or radiant heat. Finally, all fires need to feed off oxygen found in the atmosphere.

Whilst there are three ingredient elements of a fire, there are also three methods of achieving flame retardancy in a fabric: char, gas or melt.

- **Char** – Wool is naturally flame retardant and will form a char (a layer of charcoal) on its surface which blocks a certain intensity of flame and prevents it from spreading to the foam underneath.
- **Gas** – Certain additive flame retardant chemicals are released when burnt and act to smother and extinguish the flame.
- **Melt** – In some cases, the material behaves by melting like a liquid and flowing away from the flame, leaving nothing to ignite (however this can sometimes produce flaming droplets which can potentially compromise safety).

There are different approaches to flammability internationally; the UK standards (Medium Hazard) favour the barrier approach through the formation of a char, while some European standards are geared more towards melting away from the ignition source (French M1, German B1).

Below: Wool and hemp fabric creating a strong char

Though many European countries have their own flammability standards and procedures, there are some which are recognised throughout the continent.

EN 1021 Parts 1 & 2 – Cigarette & Match (Seating)

A standard test rig is constructed from fabric and foam to form a simulated chair. In Part 1 of the test a cigarette is placed in the angle of the test rig and lit. It is left to smoulder and after 60 minutes no smouldering or burning of the fabric should be observed.

In Part 2 of the test a butane flame 35mm in height is used to represent a burning match. It is applied to the fabric at multiple points for 15 seconds. After the flame is removed there should be no burning of the fabric after two minutes.

EN 13501-1 – Single Burning Item (Vertical Surfaces/Panel)

There is a multitude of vertical flammability tests throughout Europe. In an attempt to combine all these tests and bring unity to the standards, the Single Burning Item, has been developed.

The test rig represents the corner of a room with two panels covered in the fabric being tested. A flaming heat source representing a waste paper basket is positioned in the corner of the panels and ignited. A computer measures the test statistics as follows:

- Fire growth (rated A – F)*
- Smoke growth (rated s1, s2, s3)
- Flaming droplets (rated d0, d1, d2)

Multiple combinations of substrate materials and types of glue can be used and tested under EN 13501-1. To obtain a full overview of a material's performance, testing should be undertaken with it both adhered and un-adhered to different test substrates.

* A fabric can never achieve an A rating as this only applies to non-combustible material.

Top: Cigarette positioned on the test rig

Centre: Butane flame applied to the test rig, replicating a match

Bottom: Test rig for the Single Burning Item

BS 5852 Ignition Source 5 – Medium Hazard, Crib 5 (Seating)

Again a standard test rig is constructed from fabric and foam to form a simulated chair. A wooden structure, known as a Crib 5, which when lit is 16 times more intense than a match, is positioned on the test rig. The crib has a piece of alcohol soaked lint at its base which is set on fire. For a pass to be recorded, all flaming should cease within 10 minutes. The foam must not have burnt through its full thickness.

BS 7176 – Hazard levels and appropriate tests for evaluating furniture materials (Seating)

BS 7176 is a flammability performance standard based on BS 5852, but with an additional parameter based on defining "Hazard" categories linked directly to the combination of different ignition sources used in the test. Primarily for contract seating this covers cigarette, match and the Medium Hazard (Crib 5) test outlined in BS 5852 Ignition Source 5. For higher hazard applications such as hospital wards and off-shore installations a Crib 7 ignition source test is required, roughly four times the heat intensity of Crib 5. Please see hazard categories in the table below.

BS 476 Part 6 & 7 – Spread of flame (Vertical Surfaces/Panel)

In Part 7 a large radiant panel serves as the heat source. A fabric covered panel sits at a right angle to the heat source and is ignited for one minute. The rate of flame spread is then monitored and recorded. The highest classification achievable is a Class 1.

To achieve a Class 0, specifically required for building structures, Part 6 of the test must also be carried out. Part 6 is conducted within an enclosed box and temperature sensors measure the heat released from the burning fabric. Heat release is measured as this can affect how quickly a fire can progress.

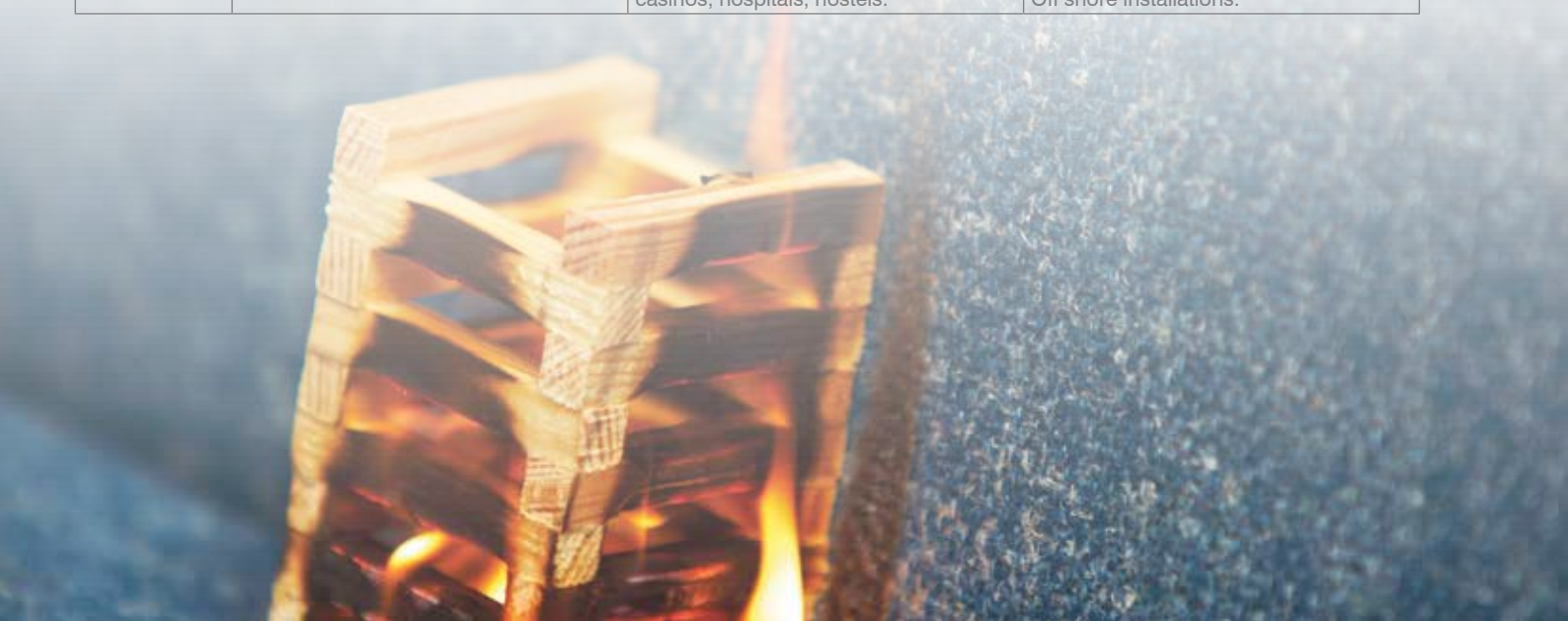
BS 5867 Part 2 – Type B (Curtains and Drapes)

There are three different specification levels in the British standard for curtain and drape fabric; Type A, B and C. Type A has the least severe requirements whilst Type C is the most demanding level. Curtains that have passed the BS 5867 Part 2 – Type B test are often regarded as suitable for non-domestic use.

For this procedure a fabric is suspended in a vertically orientated position to simulate a curtain or drape. A flame is applied to the bottom surface of the sample for a 15 second period, and during the test observations are made regarding ease of ignition, flame spread and production of droplets.

Above: Flame being applied to fabric during BS 5867 Part 2

	BS 7176 Low Hazard	BS 7176 Medium Hazard	BS 7176 High Hazard
Requirements	Ignition Source 1: EN 1021-1 (cigarette) Ignition Source 2: EN 1021-2 (match)	Ignition Source 1: EN 1021-1 (cigarette) Ignition Source 2: EN 1021-2 (match) Ignition Source 5: BS 5852 (Crib 5)	Ignition Source 1: EN 1021-1 (cigarette) Ignition Source 2: EN 1021-2 (match) Ignition Source 5: BS 5852 (Crib 7)
Typical End-use areas	Offices, schools, colleges, universities, museums, exhibitions, day centres.	Hotel bedrooms, public buildings, restaurants, public halls, pubs, bars, casinos, hospitals, hostels.	Sleeping accommodation in certain hospital wards and in certain hostels. Off shore installations.



German testing – seating and panel

DIN 66084 (Seating)

Germany's seating flammability standard covers three separate areas of testing and classification. The lowest classification Class P-c, is awarded if the material passes EN 1021-1 (cigarette). A Class P-b is achieved if the fabric also passes EN 1021-2 (match).

In order for a fabric to achieve the highest classification of P-a, the material is also required to pass the more stringent requirements of DIN 54341, also known as the paper cushion test.

As with the BS 5852 Medium Hazard (Crib 5) test, the paper cushion method requires a test rig to simulate an upholstered seat, yet unlike the wooden Crib 5 which weighs 17g, the ignition source is a far more substantial at 100g. The severity of this test and the heightened heat intensity of the burning paper cushion means that it can be difficult to pass; flaming must go out within 15 minutes and the flame spread cannot reach the edge of the rig.

DIN 4102 Part 1 – Kleinbrenner (B2) (Vertical Surfaces/Panel)

All materials used in buildings in Germany need to meet the B2 requirement which is determined using a small flame test.

The fabric specimen is suspended vertically and a 20mm high flame is applied for 15 seconds to both the fabric surface and edge. Reference lines are marked on the specimen; B2 classification is awarded if the tip of the flame does not reach the reference marks within 20 seconds on any sample. Filter paper is placed below each to determine the production of any flaming droplets.

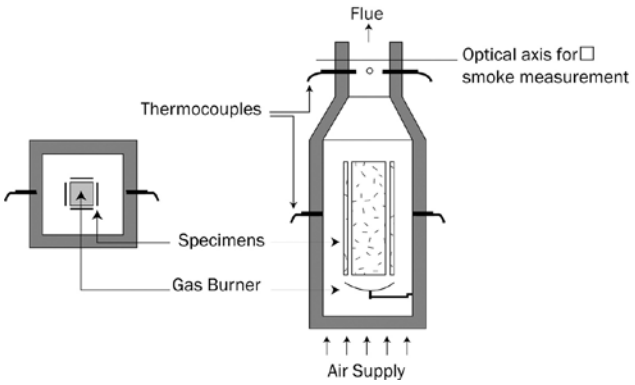
DIN 4102 Part 15/16 – Brandschacht (B1) (Vertical Surfaces/Panel)

Referred to as the "Brandschacht test", this is the main test method in Germany which measures reaction to fire and though it is designed to test building materials and vertical surfaces, it is often specified inappropriately to measure flame retardancy of seating upholstery textiles.

The testing apparatus consists of a square-shaped vertical housing equipped with a gas burner within which four fabric samples are held vertically and subjected to flames for 10 minutes. At the same time a constant flow of air is blown into the apparatus from below.

Smoke temperature and the mean residual length of the sample are taken into account during classification (residual length is the part of the specimen which has escaped burning). In order to be classified as B1, the tested fabric must show:

1. A mean residual length of not less than 150mm, with no specimen being burned away completely
2. A mean smoke gas temperature of less than 200°C



Austrian testing – seating and panel

ÖNORM B 3825 (Seating)

As with other European counterparts, Austria's procedure for testing the flammability performance of seating fabrics utilises an upholstered test rig to simulate a chair. In this test, a flame burner is applied to the centre of the rig at the angle between the seat and back. Ignition time, after flame and afterglow time are all recorded during the test.

In order for the fabric to pass, the after flame period cannot be greater than 10 seconds, and the afterglow time cannot exceed 60 seconds.

ÖNORM A3800-1 (Material Smoke Emission)

This Austrian standard measures the burning and dripping behaviour of a fabric together with fume formation. The apparatus consists of a vertical testing chamber, inside which a fabric sample is held within a frame and subsequently lit. Light sensors at the top of the chamber measure the level of smoke emitted during the procedure. Classification between Q1 and Q3 is awarded (Q1 is the highest rating).

- Q1: less than 50% mean value of maximum smoke emission
- Q2: more than 50% but less than 90% mean value of the maximum smoke emission
- Q3: more than 90% mean value of maximum smoke emission

Below: ÖNORM A3800-1 Oeti testing laboratory

French testing – seating and panel

AM 18 – NF-D-60 013 (Seating)

Seats in rows that are fixed, or difficult to move require testing to AM18 - NF D 60-013. Two individual fabric samples are tested and the test rig simulates an upholstered seat using foam and fabric over a metal frame. A gas flame 115mm in diameter is applied from a burner to the seat for a period of two minutes. The test is timed for a period of 20 minutes, and in order for the fabric to pass, a flame spread of <200mm either side of the initial flame position is required. Weight loss of the samples is also recorded.

NFP 92 507 (Vertical Surfaces/Panel)

The French standard often referred to as the 'M1' test is the principal method used not only in France, but also in Belgium, Spain and Portugal. NFP 92 507 is the method of classification and is what you will see on fabric technical specifications, yet the standard combines three different procedures; flame spread, propagation and melting. Depending on how the material performs during the tests, it receives a classification from M1 (highest) to M4. Though this test method is most suitable for building materials, it is often specified inappropriately to measure performance of upholstery fabrics.

NFP 92 503 – Brûleur électrique (Electric Burner)

The sample is placed face down on the test rig at an angle of 30° above an electric heat radiator. A small gas pilot flame is applied directly to the fabric surface at 20 seconds into the test, held in position for five seconds then withdrawn. The flame is applied again at 45 seconds and subsequently every 30 seconds throughout the five minute test. If any flaming continues after five minutes, the test is continued until the specimen extinguishes completely.

Notes are taken on the duration of flaming, the production of burning droplets and the length/width of the damaged specimen.

Classification

Classification		M1	M2	M3	>M3
Duration of combustion	s	≤5	>5	>5	>5
Damaged length	mm	-	<350	<600	>600
Damaged width	mm	-	-	<90	>90
Droplets		None	None	None	

NFP 92 504 – Propagation

This complementary test helps establish classification on samples which behave unusually during the electric burner test (by melting away from the flame or not achieving at least a classification level of M3).

The non-propagation of flame procedure involves a flame being held against the face of a horizontal sample, 10 times for five seconds; the time of after flame is measured. The time taken for the flame to spread between two reference marks at 50mm and 300mm is noted alongside the production of burning droplets.

NFP 92 505 – Dripping test

Again complementary to the electric burner, the dripping test is used to investigate the potential hazard of burning droplets observed during the primary and propagation tests.

A sample is placed on a grid 30mm below a heat radiator, underneath which sits a receptacle containing cotton wool. Heat is applied from the radiator for 10 minutes and the test is repeated four times. If the cotton wool ignites, the fabric is classified as M4, otherwise the original classification from the electric burner test is maintained.

Italian testing – seating and panel

UNI 9175 – Classe 1IM (Seating)

The Italian seating flammability standard again requires a test rig to simulate an upholstered seat. A flame is applied to three different positions in the angle of the test rig. This occurs at three different points during the test, firstly at 20 seconds, then 80 and finally 140 seconds.

Combustion, flaming and afterglow are observed, and the fabric is provided a classification from 1 to 3. Class 1 is the best result and achieved if the fabric performs satisfactorily after the full 140 second time period. Class 2 is awarded if the fabric starts to fail after 80 seconds, and the lowest classification 3, is awarded if the fabric only achieves a positive result after 20 seconds.

UNI 8456 & UNI 9174 – Classe Uno (Vertical Surfaces/Panel)

Often referred to as 'Classe Uno', the Italian requirements for flammability performance of building materials (including panel fabrics) cover two separate sections, the small burner ignitability test (UNI 8456) and the surface spread of flame test (UNI 9174). Both of these procedures must be conducted together to achieve an overall classification from Class 1 (the best) – Class 5.

The tests measure flame spread, after flame and glow, extent of damage and the production of flaming droplets. A grade is awarded based on performance during both tests.

UNI 9175 – Classe 1 IM test in progress

USA/Canada – seating, panel and curtains

North America has no national rules to regulate the requirements of contract fabrics or furniture. Regulation is often left to local fire officers or building officials and can follow various forms.

California Technical Bulletins (TB)

The state of California is one the few states to administer formal regulations for seating products through both mandatory and voluntary requirements. Because of this, many other states throughout the USA and regions of Canada adopt and specify these Californian standards.

California TB 117 – Cal 117 (Seating)

This is the primary test method for seating fabrics and involves a cigarette emission source placed on a plywood framed mock-up chair with non-FR 28 – 29.6 kg/m^3 density foam, upholstered in the fabric test specimen. The test has a pass/fail grading and is performed three times; in order to fulfil the requirements it must not smoulder for more than 45 minutes. The vertical char on the test rig must also be less than 45mm or 1.8 inches in length and the fabric cannot flame.

California TB 133 – Cal 113 (Seating)

This is a severe flammability test for furniture and textiles intended for use in "high risk" occupancies such as hospitals, nursing homes and prisons. The rigorous pass/fail criteria consist of exposing a piece of upholstered furniture to a gas burner ignition source for 80 seconds in a test burn room. Several parameters are measured during the procedure and in order for the fabric to pass, it should comply with following:

- Maximum heat release of 80kw
- Total heat release in the first 10 minutes of 25MJ maximum
- Smoke opacity at 4ft – 75% maximum opacity
- Carbon monoxide concentration not greater than 1000ppm in a 300 second interval

Temperature rise, weight loss and flaming droplets are also measured and observed during the test.

NFPA 260/UFAC (Seating)

Very similar to the California Technical Bulletin 117, this test method also utilises a cigarette ignition source and upholstered seating test rig. As with Cal 117, non FR foam is used, yet it has a lower density at 20-25 kg/m^3.
It stipulates that the vertical char does not exceed 1.8 inches/45mm and that the foam underneath cannot flame.

Where Cal 117 is required in the state of California, NFPA 260/UFAC is a national code often required for non-residential upholstery uses throughout the rest of the country.

ASTM E 84 – Tunnel Test (Vertical Surfaces/Panel)

This test is best used to assess the flammability characteristics of composites (ie. fully upholstered panels), yet panel fabric alone is often tested.

It is a ceiling fire simulation undertaken in a 25 feet long and two feet wide chamber or "tunnel". A 4.5 feet long flame is exposed to the suspended sample, then the rate at which the flame advances is measured and called the "Flame Spread Index". The opacity of the smoke exiting the chamber is also measured to calculate the "Smoke Developed Index". The results of both indices are used to classify the material into its appropriate usage category.

NFPA 701 (Curtains and Drapes)

The USA's flammability standard for curtain and drape fabrics involves the application of a flame to the bottom edge of a vertically orientated fabric. A flaming drip period of a maximum of two seconds is allowed during this test. At the end of the test the specimen is also weighed – in order to pass, a maximum of 40% weight loss is permitted.

North America's Association for Contract Textiles (ACT) sets out the following minimum performance guidelines for interior fabrics:

Upholstery	California Technical Bulletin 117-2013 Section 1 – Pass
Direct Glue Wallcoverings and Adhered Panels	ASTM E84 (Adhered Mounting Method) – Class A or Class 1
Wrapped Wall Panels and Upholstered Walls	ASTM E84 (Unadhered Mounting Method) – Class A or Class 1
Panel System Furniture	ASTM E84 (Adhered or Unadhered Mounting Method) – Class A or Class 1
Drapery	NPFA 701 Method 1 or 2 as appropriate – Pass

act

association *for* contract textiles

Other considerations

There are a number of additional factors that can affect the flammability performance of a material. Some other areas to consider include:

Foam or substrate

The result of a seating flammability test can potentially be affected by the density or the type of foam used underneath the fabric. This also applies to other composite tests, where a substrate material is required as part of the test specimen. Test reports will show what type of foam or substrate has been used in conjunction with the test fabric and this will indicate if it has been suitably tested for the end use application.

Post treatments or backing

Additional treatments to fabrics such as stain repellent chemicals or backings like foam lamination may also affect a fabric's flammability performance.

Conclusion

This guide to international flammability standards has covered some of the most important test methods applicable to contract interior fabrics, yet there are many more alongside this brief overview. We now have single standards for the European market in the form of EN 1021 (Cigarette and Match) for seating and EN 13501-1 (Single Burning Item) for panels, but national tests still dominate their individual regions and no single higher level seating standard exists.

Flammability testing remains a complex issue and contract fabrics must be designed and manufactured with these international test methods in mind. A fabric which performs well in one test may not pass another, illustrating the vastly differing approaches to flammability performance of fabrics which often have the same end use.

Further information

For further information don't hesitate to get in touch with your Camira contact who will be able to refer you to one of our technical experts.

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