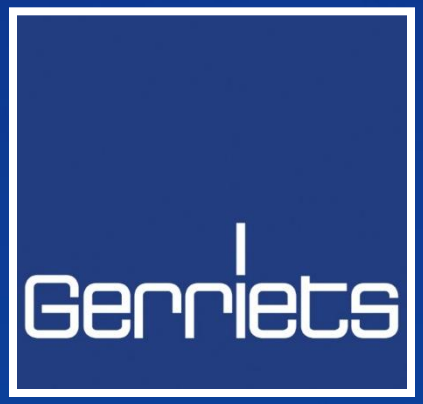


GERMAN & INTERNATIONAL FLAME RETARDANT CLASSIFICATIONS

Andreas Gause

Director Sales and Marketing

History

Today's strict rules requiring
flame retardant stage scenery and backdrops
are due in part to the Ringtheater tragedy of 1881,
in which a great Viennese theater was destroyed
and 385 lives were lost.

Definition Of Production Sites & Event Locations:

Film, Broadcast & TV Studios, Production Studios
and other Production Sites

Dramatic, Musical, & Dance Theatres,
Theatre Buildings, Multi-Purpose Halls, Open-Air Theatres,
Performance Areas in Concert Halls,
Stages in Cabarets & Varietés, Schools

Events: Shows, Open-Air Concerts, Trade Shows & Exhibitions,
Nightclubs

Introduction

In Germany, flame retardant classification standards
are determined both by German Construction Law and European Standard.

For the time being, both DIN EN 13501-1 (European Standard) and
DIN 4102-1 (German Standard) are accepted.

Other International Standards

ITALY: C-Classification

FRANCE: N-F

SPAIN: Classification 1 etc.

GREAT BRITAIN: British Standard

USA: NFPA 701

In many European countries the DIN 4102-1 is accepted.

There is a new European standard, EN 13501-1, but national standards remain in effect until this standard is more universally adopted.

Key Fire-Protection Properties

- inherently flame retardant
- flame retardant
- self-extinguishing
- no burning droplets
- low smoke density
- no toxic fumes
- insulation effect (shielding of ignition sources)

European Classification Standard

EN 13501-1
specifies fire performance requirements for construction products (excluding floor coverings), which are defined as:

"…construction products/building materials, components and equipment that are manufactured to be permanently incorporated in construction works."

Examples:

- permanently installed curtains and seats
- stage curtains
- blackout draperies
- projection screens

European Classification System

Products are ranked from A to F
according to their fire behavior (energetic contribution to fire).

Classes are also specified for associated fire-related phenomena:
- smoke (s1 to s3)
- flaming droplets / particles (d0 to d2)

Fumes and dripping are especially important criteria for evacuation.

“Facilities”

This term describes materials that are not permanently installed but must meet standards for construction/building products.

Examples
- stage sets, scenery
- decorations, textiles
- furniture

DIN 4102-1 Flame Retardant Classification

Classification of building products according to German construction regulations

Building Products Classification	German classification DIN 4102-1
Non-combustible Materials	
Non-combustible Materials	A1
	A2
Combustible Materials	
Flame-retardant Construction Products/Building Materials	B1
Normal Flammable Materials	B2
Highly Flammable Materials	B3

DIN-4102-1 Classification Descriptions

A 1	Non-flammable, with no or little organic (combustible) components. This includes almost all mineral construction products/building materials (sand, gravel, clay, concrete, brick, gypsum board ...)
A 2	Non-flammable, often contains organic (combustible) components – i.e some glass or mineral fiber products, gypsum board and gypsum fiber panels, lightweight concrete aggregates with organic (wood, plastic)
B 1	Flammable, fire resistant – i.e. certain mineral or glass fiber felts and boards, gypsum boards, wood slabs, cork, plastics etc.
B 2	Combustible, flammable, i.e., certain plasterboard composite panels, certain multi-layer lightweight panels, wood and wood products with more than 2 mm thickness with a density of more than 400 kg/m3, cork, flooring, roofing felt, asphalt waterproofing membranes, plastics ...
B3	Flammable, highly flammable – i.e. wood and wood products with less than 2 mm thickness with a density of less than 400 kg/m3.

Building Products Classification

Classification of building products according to German construction regulations and corresponding new European Union standard EN 13501-1 (excluding floor coverings)

Building Products Classification	Additional Requirements		European Standard according to DIN EN 13501-1
	No smoke	No droplets	
Non-flammable materials	X	X	A1
	X	X	A2 – s1, d0
Flame-retardant construction products/ building materials	X	X	B – s1, d0 / C –s1, d0
		X	A2 – s2, d0 / A2 –s3, d0 / B –s2, d0 / B –s3, d0 / C –s2, d0 / C –s3, d0
	X		A2 –s1, d1 / A2 –s1, d2 / B –s1, d1 / B –s1, d2 / C –s1, d1 / C –s1, d0
			A2 –s3, d2 / B –s3, d2 / C –s3, d2
Normal flammable materials			D –s1, d0 / D –s2, d0 / D –s3, d0 / E
			D –s1, d0 / D –s2, d1 / D –s3, d1 / D – s1, d2 / D –s2, d2 / D –s3, d2
			E –d2
Highly flammable materials			F

Floor Coverings Classification

Classification of building products with German construction regulations and corresponding new European Union EN 13501-1 for floor coverings

Construction supervision requirements	**European classification DIN EN 13501-1**
Non-flammable materials	$A1_{fl}$
	$A2_{fl}$
Flame-retardant construction products/building materials	B_{fl} – s1 / C_{fl} – s1
Normal flammable materials	$A2_{fl}$ –s2 / B_{fl} –s2 / C_{fl} –s2 / D_{fl} –s1 / D_{fl} –s2 / E_{fl}
Highly flammable materials	F_{fl}

“Facilities” Classification

Materials classified as “facilities” must meet the same requirements
as building products for fire behavior.
The fire behavior can also be proved with specific standards for these materials
if the classification of the fire behavior is equivalent to
the construction product/building material class of the DIN 4102-1
and if there is a proof of a recognized (accredited) test institute.
This can apply for a fire behavior proof for textiles and furniture
according to the standards mentioned hereafter:

- DIN 66080 (textile fabrics)
- DIN 66084 (upholstery composites)
- DIN 66090-1 (textile floorings)
- DIN EN 1021-1 and -2 (soft furniture/upholstery)
- DIN EN 1624, DIN EN 1625 (industrial and technical textiles)
- DIN EN 13772, DIN EN 13773 (curtains and drapes)

EN 13501-1 Classification

Scheme: classification – smoke – burning droplets

Class. A: no contribution to fire very low contribution to fire	non-flammable
Class. B: minor contribution to fire Class. C: acceptable contribution to fire Class. D: contribution to fire Class. E: normal fire behavior	flammable
Class. F: no properties specified / found	

Additional Information

Key to abbreviations used in DIN EN 13501-1.

Derivation of Abbreviations	Criteria	Application
s = smoke	Smoke Emission	Smoke emission requirements
d = droplets	Burning Droplets	Droplet requirements
fl = floorings		Fire behavior classification for floorings

Smoke Emission

Smoke Emission	
s1	negligible
s2	low
s3	strong

Droplets

Droplets	
d0	No burning droplets within the first 10 minutes
d1	No burning droplets **with** an afterburn phase > 10 seconds within the first 10 minutes
d2	Neither d0 nor d1

Important Note !

It is NOT possible to directly compare the DIN 4102-1 classifications to the new European classifications.

As a guideline only, it is possible to find a correlation between the construction regulation classifications (e.g., non-combustible, hard to burn, etc.) and the European classification according to EN 13501-1

Official comparisons between different flame retardant classification standards can be made only by nationally authorized institutes (example: Germany's DIBt Berlin).

Classification according Euro Classification

Ranking according European Classification (DIN EN 13501-1) according the building inspection appointment referring to Buidling Regulation A.				
Building Inspection Appointment	**Definition according DIN 4102**	**European Classification according DIN EN 13501-1**		
		Energetic contribution to fire	**Production of smoke**	**Behavior of droplets**
Non-flammable	A1	A1		
	A2	A2	s1	d0
Flame-retardant	B1	B, C	S1	d0
		A2, B, C	S2	d0
		A2, B, C	S3	d0
		A2, B, C	S1	d1
		A2, B, C	S1	d2
		A2, B, C	s3	d2
Normal flammable materials	B2	D	s1	d0
			s2	d0
			s3	d0
		E		
		D	s1	d2
			s2	d2
			s3	d2
		E		d2
No performance noted *	B3	F		

*According to building inspecton equivalent to „flammable“

Fire Tests according to DIN 4102-1

New European fire classifications according EN 13501-1
Test according:

EN 13823	SBI ≡ single burning item
EN 11925-2	small burner
EN ISO 1182	750°C-Oven (non-flammable)
EN 1716	calorific value (non-flammable)
EN 9239-1	Test of floor coverings

The Way To Classification

National:

DIN 4102-1 describes: the test device
implementation and test conditions
the classification

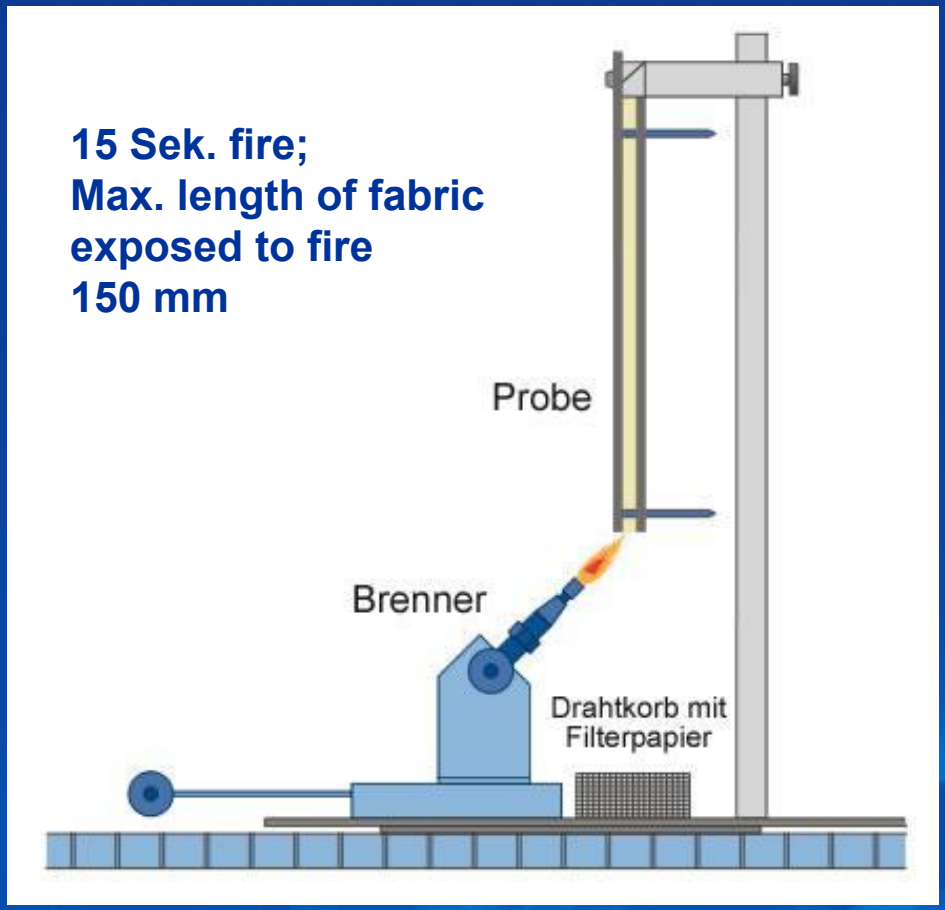
European:

Classification Standard
EN 11925-2 describes the test device (here small burner)
Product standards
EN 13984 describes e.g. Implementation and test conditions
classification standard
EN 13501-1 describes the classification

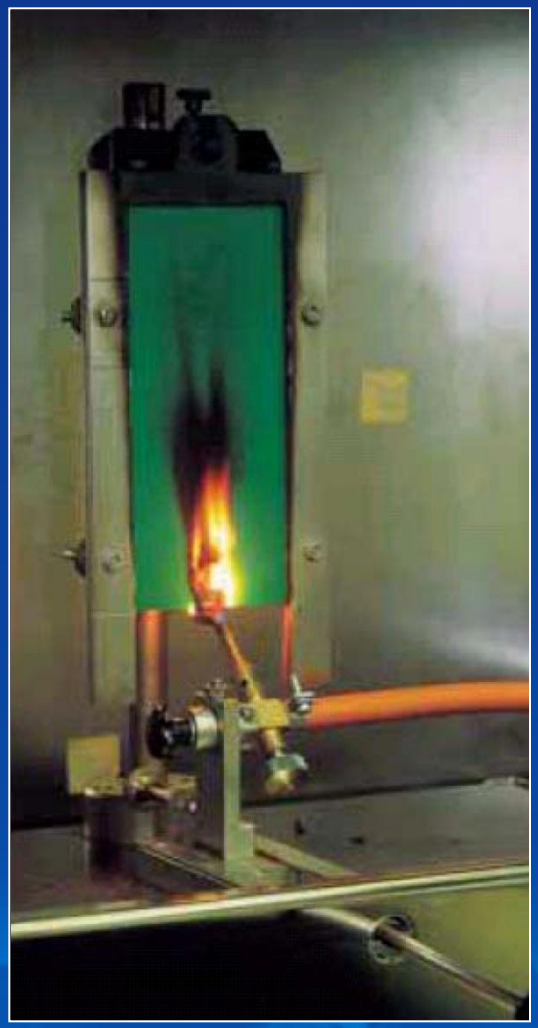
DIN 4102-1 Lighted Box Test

Small lighted box

DIN 4102 B2 (small burner test)



Fire Pit Test according DIN 4102-1 or Small Burner Test according EN 11925-2



Example: Fire exposed to edge

Requirement : approx. 40 W
Limit:
- Flame tip reaches the measure limit at 15 cm
Additional parameter:
- burning droplet

Comparison DIN 4102-1 / EN 11925-2		
Size of material sample	9 cm x 13 cm 9 cm x 23 cm	9 cm x 25 cm
Limits flame tip	15 cm	
Fire	15 Sec.	15 Sek. forE 30 Sec. B to D
Observation	20 Sec.	20 Sec. forE 60 Sec. B to D
Burning droplets	Burning on the filter paper	Burning of the filter paper
Visual observation of fire-development		

According DIN 4102-1 or Small Burner Test according EN 11925-2

Example: surface ignition

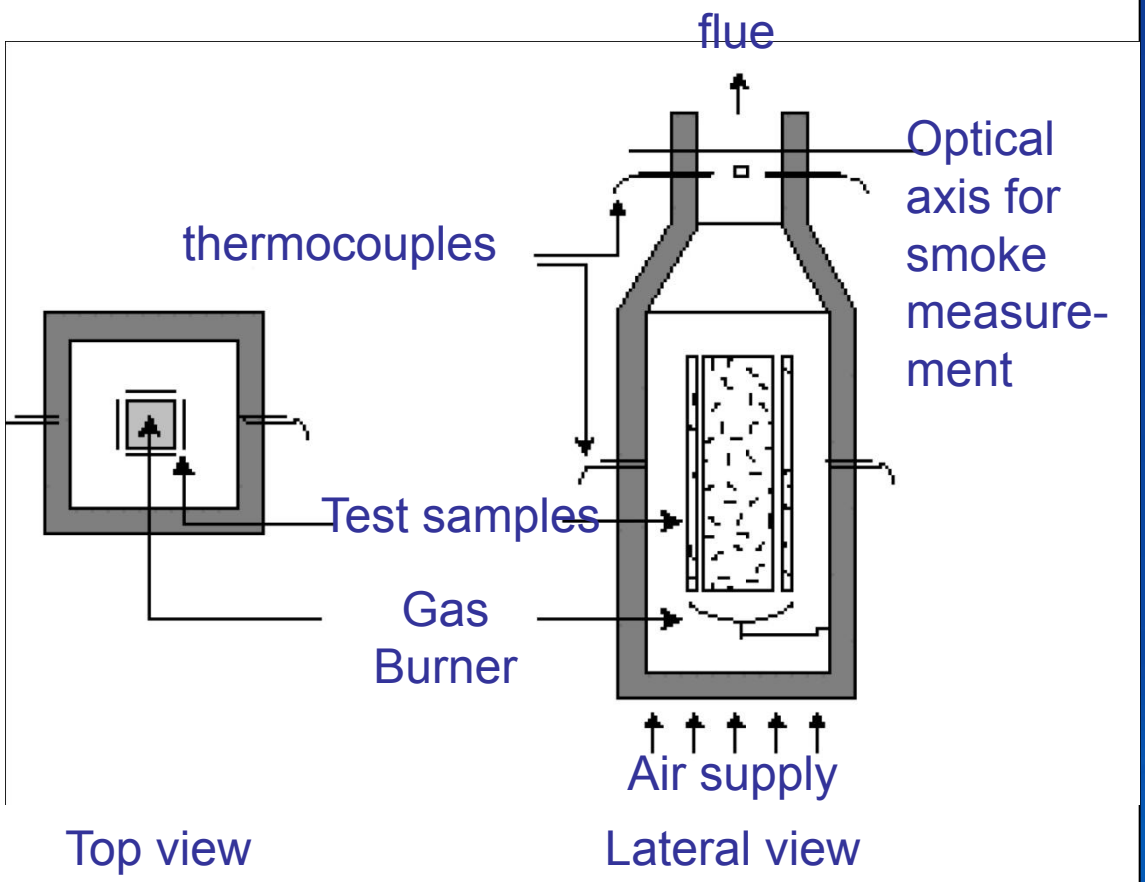
Example: negative test result

According DIN 4102-1 or Small burner test according EN 11925-2

Example: negative test result

DIN 4102-1 Fire Pit Test

Functional Scheme



Use/requirement: approx. 24 KW
size of sample: 100 cm x 19 cm

Limits:
- Max. smoke temperature: 200°C
- length of remaining sample: min. 15cm

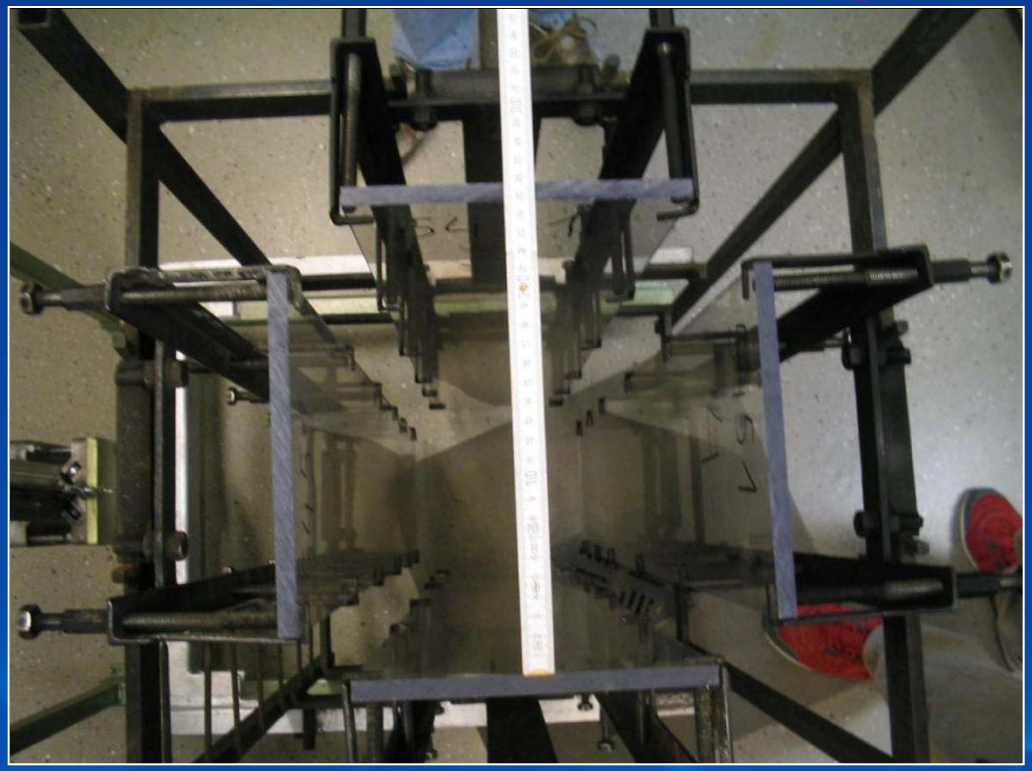
Additional parameters:
- Smoke development
(Integral ≥ 400 % min)
- burning droplets

Test duration:
- fire: 10 Min.
- until fire extinguish

DIN 4102-1 Fire Pit Test

Funktionsschema

Rauchabzug

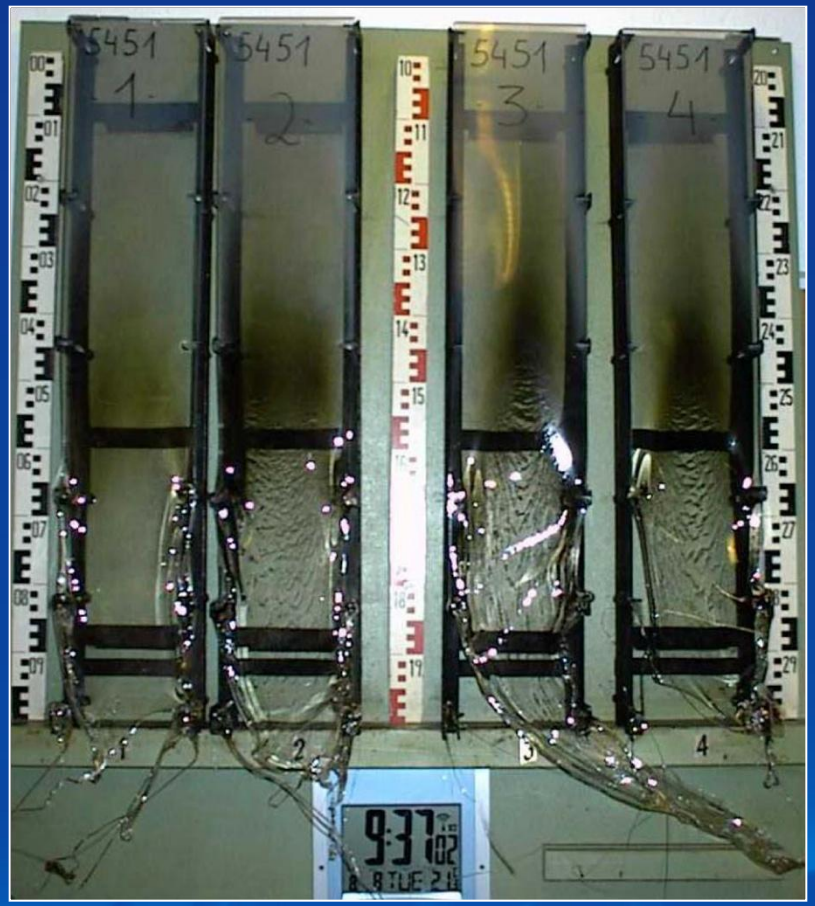


Top view onto the chimney board

Ignition of glass clear PE panels

DIN 4102-1 Fire Pit Test

Ignition of glass clear PE panels:
crossfall „burning droplets“



Specimen after fire pit test

DIN 4102-1 Fire Pit Test, Negative Test Results

PC Panel
after 2 years use

Stage Curtain

Coated Fabric

EN 13 823 SBI = Corner Ignition

Functional Scheme

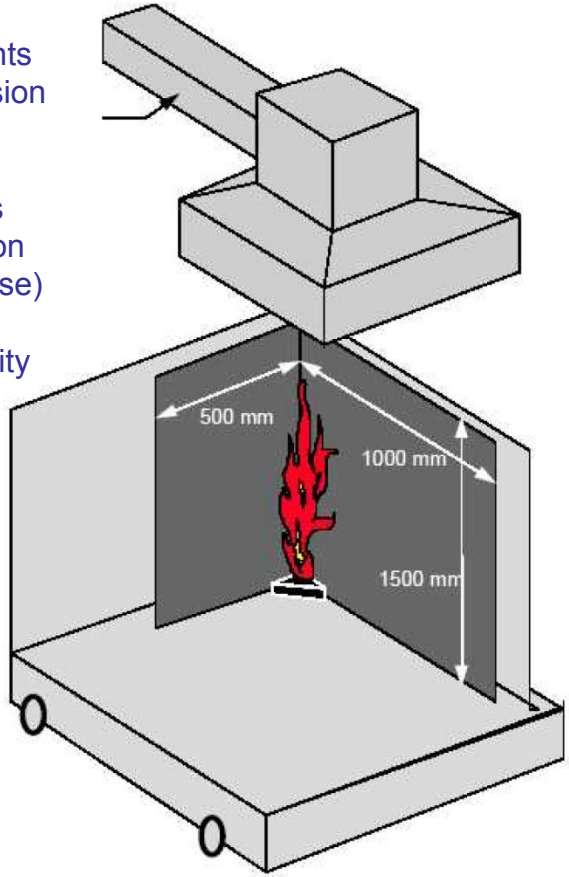
Measurements within emission current

Gas analysis (determination of heat release)

Smoke density

Volume flow

Temperature



Use/requirement: 30 KW Burner Performance

Sample size: (150 cm x 50cm) and (150cm x 100cm)

Parameters:
- Oxygen Concentration
- Light Attenuation

Values:
- HRR ≡ Heat Growth
- FIGRA ≡ Fire Growth Rate
- SPR ≡ smoke growth
- SMOGRA ≡ Smoke Growth Rate
- THR ≡ Total Heat Release
- TSP ≡ Ttotal Ssmoke Production

Additional Parameters:
- LFS ≡ Longitudinal Flame Spread
- Burning Droplets

Duration of Fire Exposure: 1.200 Seconds ≡ 20 Minutes

Duration of Test. 1.500 Seconds ≡ 25 Minutes

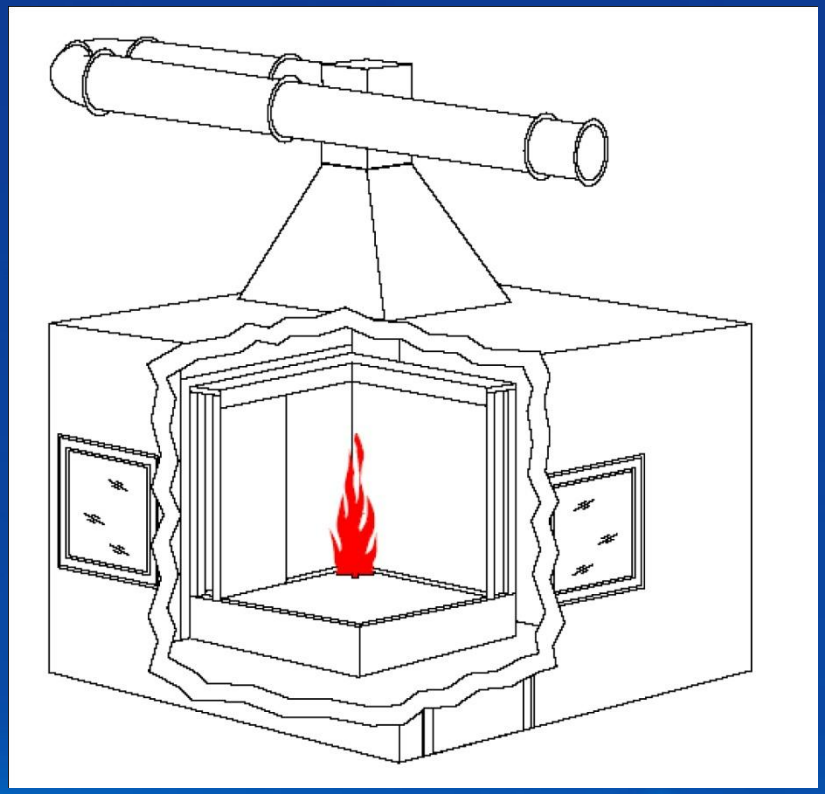
EN 13 823 SBI = Corner Ignition

Flame Requirement ≈ 30 KW

Proportions

EN 13 823 SBI = Corner Ignition

Schematic View



Classification Table1 according EN 13501-1►

Tabelle 1 — Klassen zum Brandverhalten von Bauprodukten mit Ausnahme von Bodenbelägen und Rohrisolierungen

Klasse	Prüfverfahren	Klassifizierungskriterien	Zusätzliche Klassifikation
A1	EN ISO 1182[a] und	$\Delta T \leq 30$ °C und $\Delta m \leq 50$ % und $t_f \leq 0$ s (d. h. keine anhaltende Entflammung)	—
	EN ISO 1716	$PCS \leq 2{,}0$ MJ/kg[a] und $PCS \leq 2{,}0$ MJ/kg[b, c] und $PCS \leq 1{,}4$ MJ/m^2[d] und $PCS \leq 2{,}0$ MJ/kg[e]	—
A2	EN ISO 1182[a] oder	$\Delta T \leq 50$ °C und $\Delta m \leq 50$ % und $t_f \leq 20$ s	—
	EN ISO 1716 und	$PCS \leq 3{,}0$ MJ/kg[a] und $PCS \leq 4{,}0$ MJ/m^2[b] und $PCS \leq 4{,}0$ MJ/m^2[d] und $PCS \leq 3{,}0$ MJ/kg[e]	—
	EN 13823	$FIGRA \leq 120$ W/s und $LFS <$ Rand des Probekörpers und $THR_{600\,s} \leq 7{,}5$ MJ	Rauchentwicklung[f] und brennendes Abtropfen/Abfallen[g]
B	EN 13823 und	$FIGRA \leq 120$ W/s und $LFS <$ Rand des Probekörpers und $THR_{600\,s} \leq 7{,}5$ MJ	Rauchentwicklung[f] und brennendes Abtropfen/Abfallen[g]
	EN ISO 11925-2[i] Beanspruchung = 30 s	$F_s \leq 150$ mm innerhalb von 60 s	
C	EN 13823 und	$FIGRA \leq 250$ W/s und $LFS <$ Rand des Probekörpers und $THR_{600\,s} \leq 15$ MJ	Rauchentwicklung[f] und brennendes Abtropfen/Abfallen[g]
	EN ISO 11925-2[i] Beanspruchung = 30 s	$F_s \leq 150$ mm innerhalb von 60 s	
D	EN 13823 und	$FIGRA \leq 750$ W/s	Rauchentwicklung[f] und brennendes Abtropfen/Abfallen[g]
	EN ISO 11925-2[i] Beanspruchung = 30 s	$F_s \leq 150$ mm innerhalb von 60 s	
E	EN ISO 11925-2[i] Beanspruchung = 15 s	$F_s \leq 150$ mm innerhalb von 20 s	Brennendes Abtropfen/Abfallen[h]
F	Keine Leistung festgestellt		

[a] Für homogene Bauprodukte und substantielle Bestandteile von nichthomogenen Bauprodukten.
[b] Für jeden äußeren nichtsubstantiellen Bestandteil von nichthomogenen Bauprodukten.
[c] Alternativ kann ein äußerer nichtsubstantieller Bestandteil ein $PCS \leq 2{,}0$ MJ/m^2 haben, vorausgesetzt das Produkt erfüllt die folgenden Kriterien der EN 13823: $FIGRA \leq 20$ W/s und $LFS <$ Rand des Probekörpers und $THR_{600\,s} \leq 4{,}0$ MJ und s1 und d0.
[d] Für jeden inneren nichtsubstantiellen Bestandteil von nichthomogenen Bauprodukten.
[e] Für das Produkt als Ganzes.
[f] In der letzten Phase der Entwicklung des Prüfverfahrens wurden Änderungen des Rauchmesssystems eingeführt, deren Auswirkungen weitere Untersuchungen erfordern. Daraus kann sich eine Korrektur der Grenzwerte und/oder der Parameter zur Beurteilung des Rauches ergeben.
s1 = $SMOGRA \leq 30$ m^2/s^2 und $TSP_{600\,s} \leq 50$ m^2; s2 = $SMOGRA \leq 180$ m^2/s^2 und $TSP_{600\,s} \leq 200$ m^2; s3 = weder s1 noch s2
[g] d0 = kein brennendes Abtropfen/Abfallen in EN 13823 innerhalb von 600 s;
d1 = kein brennendes Abtropfen/Abfallen länger als 10 s in EN 13823 während 600 s;
d2 = weder d0 noch d1;
Entzündung des Papiers in EN ISO 11925-2 führt zu einer Einstufung in d2.
[h] Bestanden = keine Entzündung des Papiers (keine Einstufung); nicht bestanden = Entzündung des Papiers (Einstufung d2).
[i] Bei einer Flammenbeanspruchung der Oberfläche und – sofern für die Endanwendung des Produkts relevant – einer Flammenbeanspruchung der Probenkante.

EN 9239-1 (DIN 4102-14) Test Device for Floor Coverings

View

View of radiation source
and displaced sample holder

EN 9239-1 Test Device for Floor Coverings

During testing

Sample Size (105 cm x 23cm)

Exposure to:
- **Heat Radiator**
- **Pilot Flame**

Measure Parameters:
- **Flame Spread**
- **Smoke Growth**

Flame Spread [cm] ≡ „critical radiation intensity“: required radiation energy to make the construction products/building materburn.

EN 9239-1 Test Device for Floorings

Excerpt of the Classification Table 2 according EN 13501-1 for Floorings

Samples of 3 tests after inflammation/ exposure to fire

Klasse	Prüfverfahren	Klassifizierungskriterien
$A1_{fl}$	prEN ISO 1182 (1); und	$\Delta T \leq 30°C$; und $\Delta m \leq 50\%$; und $t_f = 0$ (d. h. keine anhaltende Entflammung)
	prEN ISO 1716	$PCS \leq 2,0$ MJ/kg (1) und $PCS \leq 2,0$ MJ/kg (2) und $PCS \leq 1,4$ MJ/m² (3) und $PCS \leq 2,0$ MJ/kg (4)
$A2_{fl}$	prEN ISO 1182 (1); oder	$\Delta T \leq 50°C$; und $\Delta m \leq 50\%$; und $t_f \leq 20s$
	prEN ISO 1716; und	$PCS \leq 3,0$ MJ/kg (1) und $PCS \leq 4,0$ MJ/m² (2) und $PCS \leq 4,0$ MJ/m² (3) und $PCS \leq 3,0$ MJ/kg (4)
	prEN ISO 9239-1 (5)	Kritischer Wärmestrom (6) ≥ 8,0 kW/m²
B_{fl}	prEN ISO 9239-1 (5) und	Kritischer Wärmestrom (6) ≥ 8,0 kW/m²
	prEN ISO 11925-2 Beanspruchung = 15s	$Fs \leq 150$mm innerhalb von 20s
C_{fl}	prEN ISO 9239-1 (5) und	Kritischer Wärmestrom (6) ≥ 4,5 kW/m²
	prEN ISO 11925-2 (8) Beanspruchung = 15s	$Fs \leq 150$mm innerhalb von 20s
D_{fl}	prEN ISO 9239-1 (5) und	Kritischer Wärmestrom (6) ≥ 3,0 kW/m²
	prEN ISO 11925-2 (8) Beanspruchung = 15s	$Fs \leq 150$mm innerhalb von 20s
E_{fl}	prEN ISO 11925-2 Beanspruchung = 15s	$Fs \leq 150$mm innerhalb von 20s
F_{fl}	Keine Leistung festgestellt	

Test Methods

Application	Fire Classification Standard / Test
Building/ Construction Products/Building Materials	DIN 4102… NF P 92-501… BS 476 part 7 EN 13823, SBI-Test EN ISO 11925-2
Transport	Airplane: FAR 25853; ISO… Ship: IMO Automobile : MVSS 302; ISO 3795
Furniture Covers/Textiles/‘Floor Coverings	BS 5852… EN 1021 DIN 4102 – 14 (Radial Panel Test)…
EEE / Plastics	UL 94 : V0 - 2 LOI Test ICE 60335 (Glow wire test)

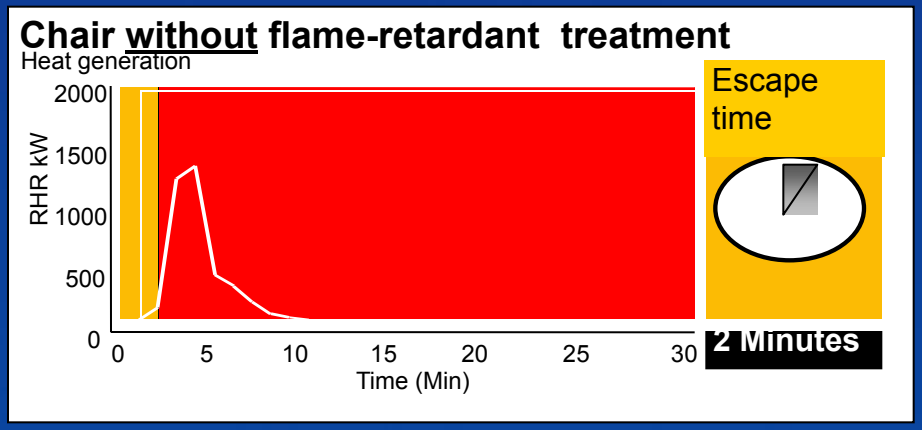
Why use flame retardants?

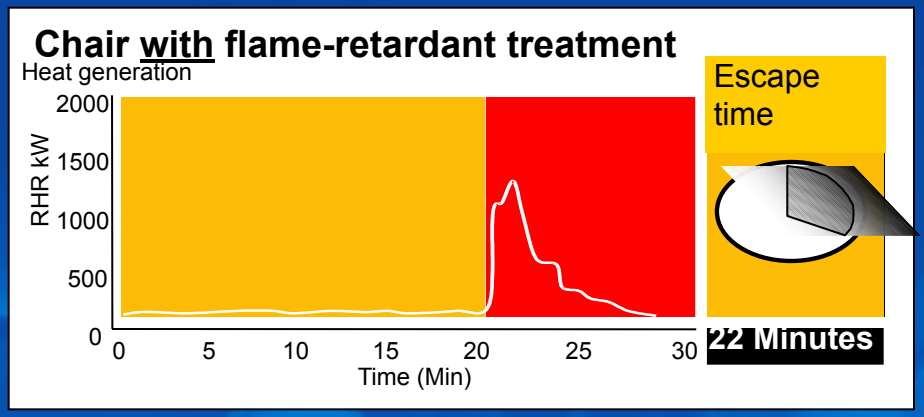
A study of the EFRA (European Flame Retardants Association) shows that in Europe alone annually about 5,000 people lose their lives due to fires.

This corresponds to 1 to 2 people per 100,000 population.

Why use flame retardants?

The following investigation proofs
that in many cases flame-retardant treatment saves lives:



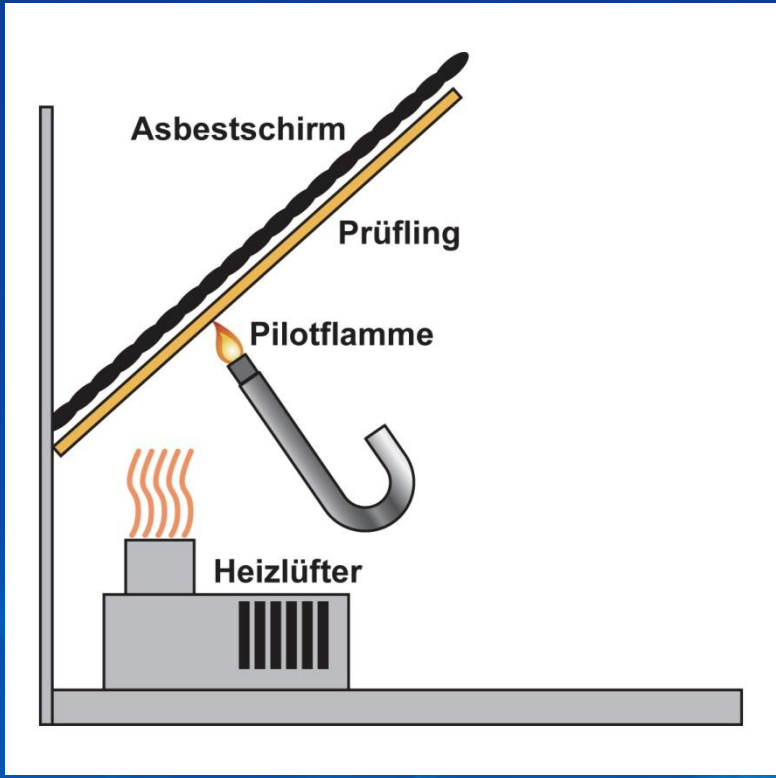


French Standards – as comparision

Standard: NF-P92-503
Type: Fire Test

Description: Flame impingement of an angular material sample under heat growth

Fire Test:



Preparations: none

Burn:

Arrangement sample to test: angular
size of sample to test length 60 cm / width 18 cm
Type of inflammation surface ignition
Height of flame 30 mm
Angle of flame acc. To device setting
Time of ignition 5 Sek. several times
Gas Propane

Criteria/Evaluation:

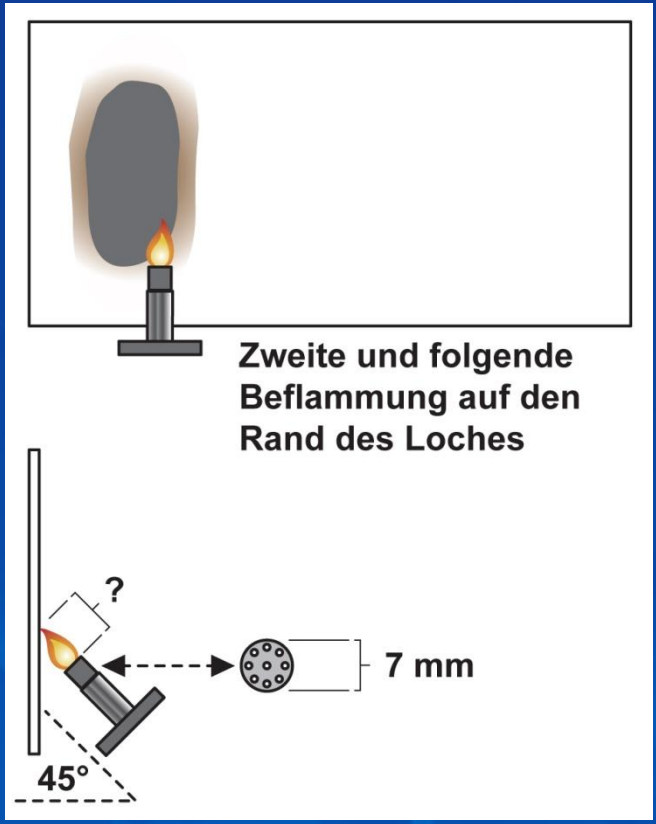
- Burn Time
- Droplets (burning/non-burning)
- Length/Width of damaged material sample

French Standard – as comparison

Standard: NF-P92-503
Mode: Fire Test

Description: Inflammation of a vertically arranged fabric in an angle of 45°

Fire Test:



Preparation: none

Burn:
Arrangement of Test Object: Vertically
Size of Test Object: Length 23 cm / Width 46 cm
Type of flame: Surface Ignition
Height of flame: 20 mm (vertical)
Angle of applied flame: 45°
Duration of flame: 5 sec.*
Gas Propane

Criteria/assessment:**
M1 = max. 2 sec.. .Afterburn time
M2 = max. 5 sec.. .Afterburn time
M2 = over 5 sec ,…Afterburn time

Drain (burning/not burning) is being noted.
Burning dripping leads to devaluation by one level (i.e. M1 to M2)-

Remarks:
* = The flame will be repeated up to 20 times in intervals of 3 seconds From the second time the flame is being directed onto the edge of the previous hole.
** = Only with a bad value, a second test is being made.

French Standard – as comparison

Classification Criteria (Excerpt from the original document)

NF-P92-503	
M1	Burn Time ≤ 5 sec. + No Dripping Material
M2	Burn time ≤ 5 sec. + burning droplets or **Burn Time > 5 sec. + no dripping material**
M3	Burn Time > 5 sec. + no dripping material + damaged/destroyed parts max. 90 mm (width) and 450-600 mm (length) or Burn Time > 5 sec. + burning droplets + damaged/destroyed parts < 350 mm (Length)
M4	Burn time> 5 sec. + burning droplets + damaged/destroyed parts max. 90 mm (width) and 450-600 mm (length) or Flame propagation speed < 2 mm/sec. + burning droplets or ignition of cotton/wad

Must be tested additionally in case of hole formation:
NF-P92-504
M1 = Burn Time ≤ 2 sec.
M2 = Burn Time ≤ 5 sec.
M3 = Burn Time > 5 sec.

Burning Droplets each leading to a devaluation to a lower classification level

VBG Specification

Labor Protection Law	Buidling Regulations	Specific Security Law of the State and Federal
Labor Protection Law **Arbeitsstättenverordnung** **Unfallverhütungsvorschriften** **BGV A1** § 2 Basic obligations of the entrepreneurs § 3 Risk Assessment **BGV C1** **§ 29 Abs. 2 + 3** - Structures and Decorations flame-retardant - Furniture and props: No special requirements - Deviations are possible – then special fire protection measuers must be taken.	**Federal Building Codes** **Federal Regulation for Meeting Facilites** **DIN 4102** Fire Behavior of building materials and components **DIN EN 13501** Classification of construction products and designs according their fire behavior	**Examples :** - Permission for fireworks - Special use permit - 1. ExplosionV - Regulations on the prevention of fires (VVB)

These legal requirements are taken into account in scripture.

If necessary, additional requirements to meet theselegal sources

Table: Key legal principles for fire protection. (In some cases, additional legal basics may apply.

VBG Specification

Flammability Of Textiles And Furniture				
Standard	**DIN 66084**	**DIN EN 1021-1 and-2**	**DIN EN 13772, DIN EN 13773**	**DIN EN 14533**
Application	Upholstery Composites	Upholstery	Drapes and Curtains	Beddings
Ignition Source	Pa: Paper Cushions100g Pb: Butane Flame Pc: Cigarette	Cigarette, Butane Flame	Heat Radiator and small burner (Propane Flame	Cigarette, Small Flame
Fire Classification	Pa (highest requirement), Pb, Pc (lowest requirement	Passed, Not passed	1 (highest requirement) to 5 (lowest requirement)	A (highest requirement) to C (lowest requirement)

Table: Standards of Classification referring Fire Performance of Textiles and Furniture (Choice)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Thank you very much for your attention !

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