Furniture Fire Safety Seminar

How to make sure that your sofa is fire safe?

FLAME RETARDANTS EUROPE

IFV Instituut Fysieke Veiligheid

EUROPEAN FIRE SAFETY WEEK
18-21 NOVEMBER 2019

21 NOVEMBER 2019
FURNITURE FIRE SAFETY

L42 Business Centre
Rue de la Loi 42, 1040 Brussels

Introductory remarks

Guillermo Rein

Professor of Fire Science, Imperial College London

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FURNITURE FIRE SAFETY

9:30 – 10:00		**REGISTRATION**
10:00 – 10:10		**INTRODUCTORY REMARKS FROM MODERATOR** **Guillermo Rein,** Professor of Fire Science, Imperial College London
10:10 – 10:25		**FIRE SAFETY OF UPHOLSTERED FURNITURE: THE VISION OF THE EUROPEAN FIRE SERVICES** **Rene Hagen**, Professor of Fire Safety, Institute for Safety (IFV)
10:25 – 10:40		**COMPARISON OF COUNTRY FURNITURE STANDARDS USING CORNER BURNS, FIRE SPREAD & SMOKE TOXICITY** **Matthew Blais**, Director of Fire Technology, Southwest Research Institute (SWRI)
10:40 – 10:55		**UNITING FIRE SAFETY, HEALTH AND CIRCULAR AGENDAS** **Pär Stenmark,** Chief Regulatory Affairs Officer, IKEA Range & Supply
10:55 – 11:25		**COFFEE BREAK**
11:25 – 12:20		**PANEL DISCUSSION AND Q&A WITH AUDIENCE**
12:20 – 12:30		**CONCLUDING REMARKS FROM MODERATOR**
12:30 – 13:30		**NETWORKING LUNCH**

21 NOVEMBER 2019
FURNITURE FIRE SAFETY

René R. Hagen
Professor of Fire Safety, Institute for Safety (IFV)

Lectures and write about fire safety.
Forensic studies of accidental fires.
30 years in the fire service.
Advises the Dutch Government on fire regulations.

Matthew Blais
Director of Fire Technology, Southwest Research Institute (SWRI)

Material research, fire testing, certification, and product development.
Served for many years in the USA military.
Also expert in counter-terrorism and chemical weapons.

Pär Stenmark
Chief Regulatory Affairs Officer, IKEA Range & Supply

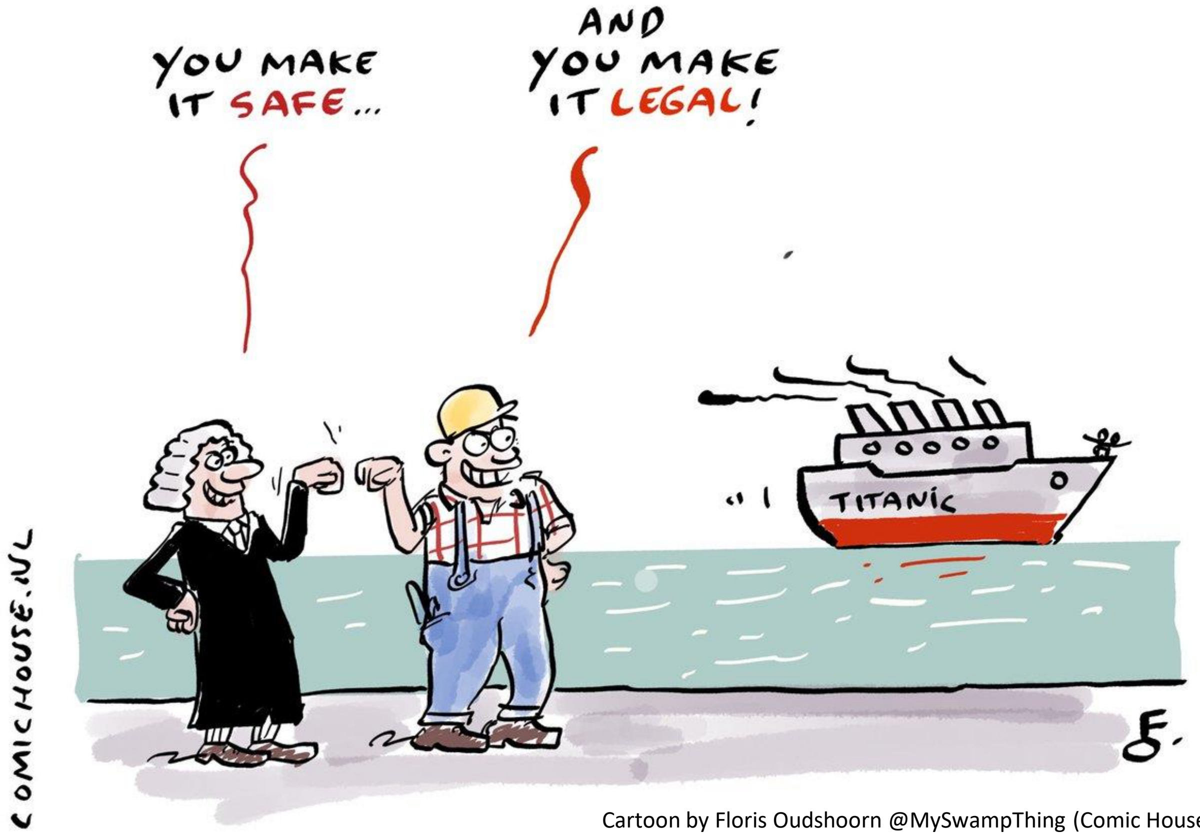
Regulatory affairs of products, materials, innovation, production and distribution.
Quality, Technology and Forestry.
Development of the FSC forest certification scheme.

Focus is on sofas because together with mattresses, they are among the largest fuel load in residential fires worldwide.

BRE

“The Titanic complied with all codes. Lawyers can make any device legal, only engineers can make them safe"

Prof Brannigan, University of Maryland



Cartoon by Floris Oudshoorn @MySwampThing (Comic House, 2018).

Fire Engineering

Fire Engineers make the world safer from fire: protecting people, their property, and the environment.

Layers of Protection* (after Prof Drysdale):

1. **Prevention****
2. Detection
3. Evacuation
4. Compartmentation
5. Suppression
6. Structural Resilience

*Not all layers must be present in a building, but all must be considered as least.

Not all layers contribute equally or cost equal amounts, but **the single most important layer of protection is prevention (avoid the fire from taking place, disrupt the fire triangle)

Fire Safety of upholstered furniture: The vision of the European fire services

René R. Hagen

Professor of Fire Safety,
Institute for Safety (IFV)

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Fire safety of upholstered furniture

The vision of the European Fire Services

European Fire Safety Week
René Hagen, Professor of Fire Safety
Brussels, 21th November 2019

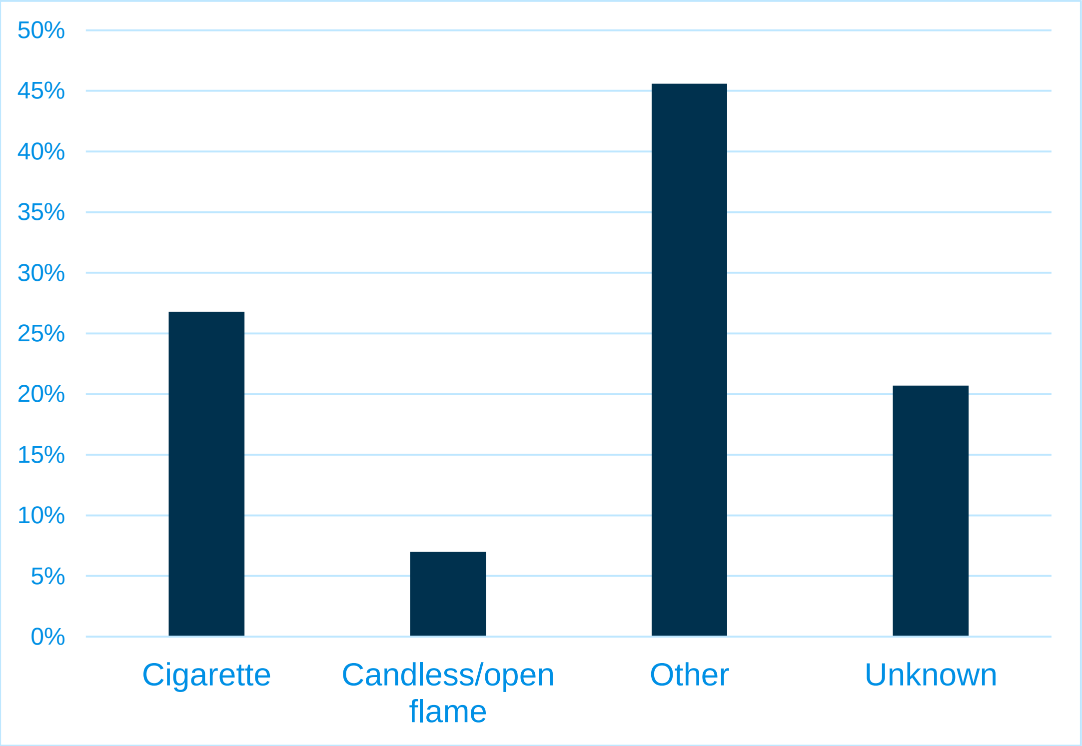
The vision of the European Fire Services

Don’t focus on the behavior of the components but look at the performance of the end-use-product and prevent the foam fillings to catch fire.

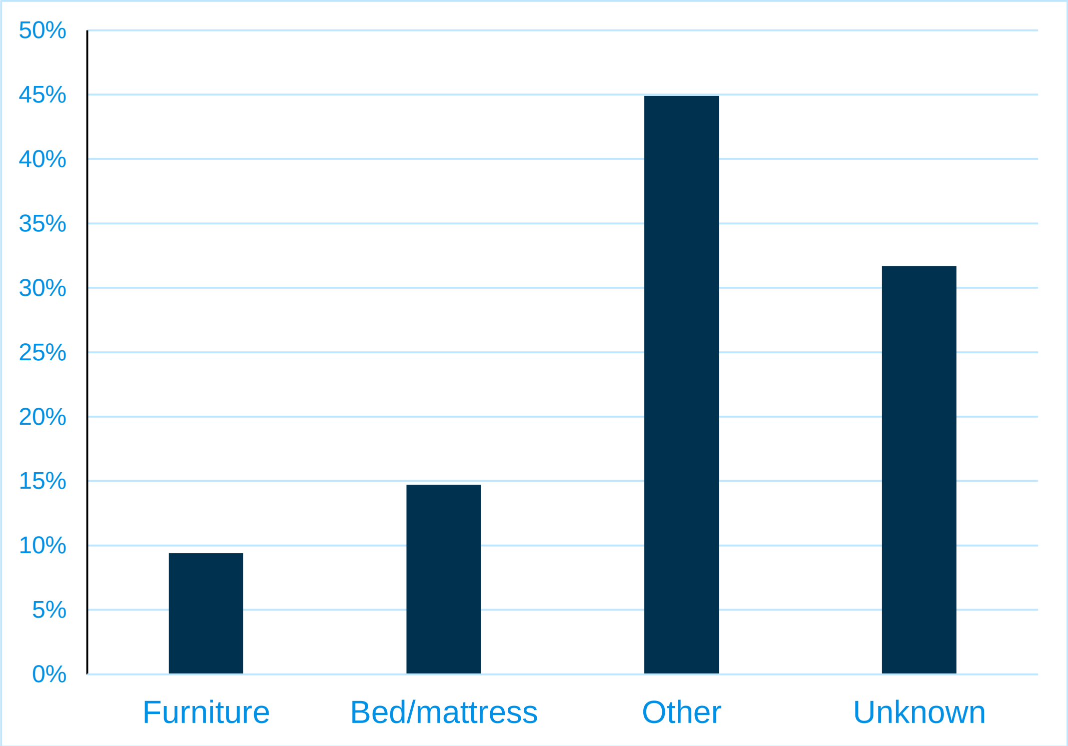
Fatal fires in the European Union

- Yearly about 6.000 fatalities due to fires
- 80 – 90% of the fatalities in the domestic area
- At least 25% of these fatal domestic fatalities are caused by the flammability of upholstered furniture and mattresses

Ignition source and origin of fire



Ignition source (N=2293)

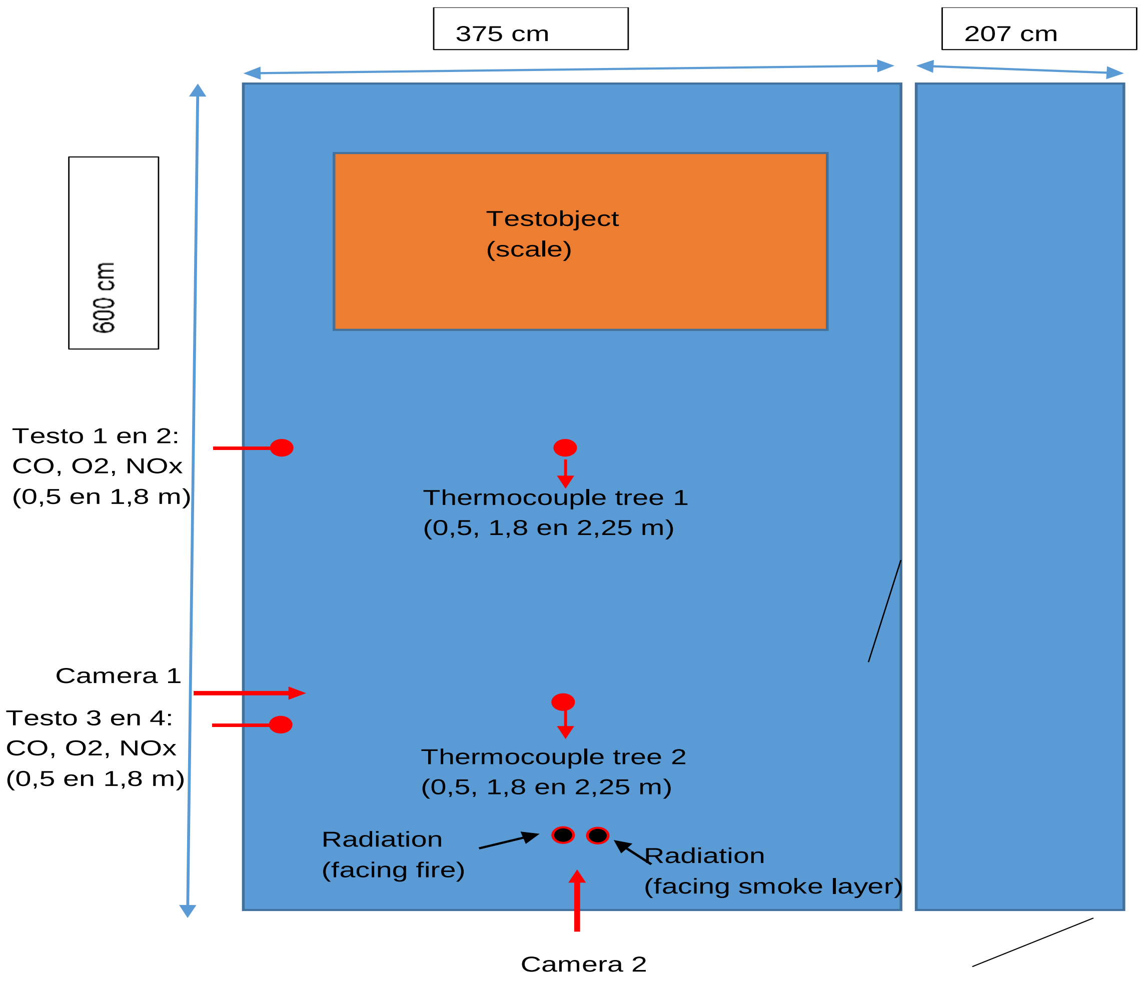


Origin of fire (N=1566)

Assignment given by the Federation of the European Union Fire Officer Associations (FEU)

- *Define and determine a set of (existing or modified) testing methods, which fire departments throughout Europe deem necessary in order to increase survivability and escape capabilities during domestic fires. The test methods have to be widely applicable to upholstered furniture, regardless of the material, and should serve as input towards manufacturers, suppliers and (legal) regulations and standards.*

Impression tests



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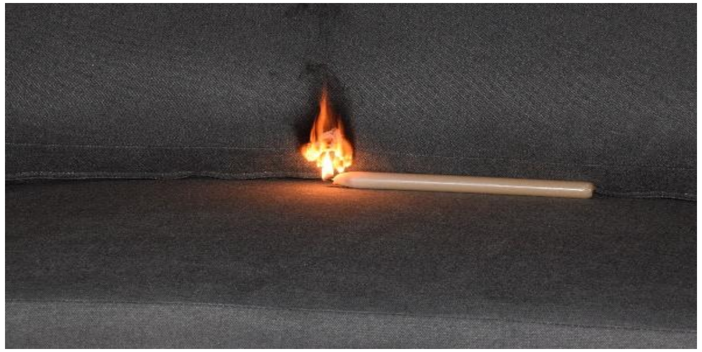
Impression tests



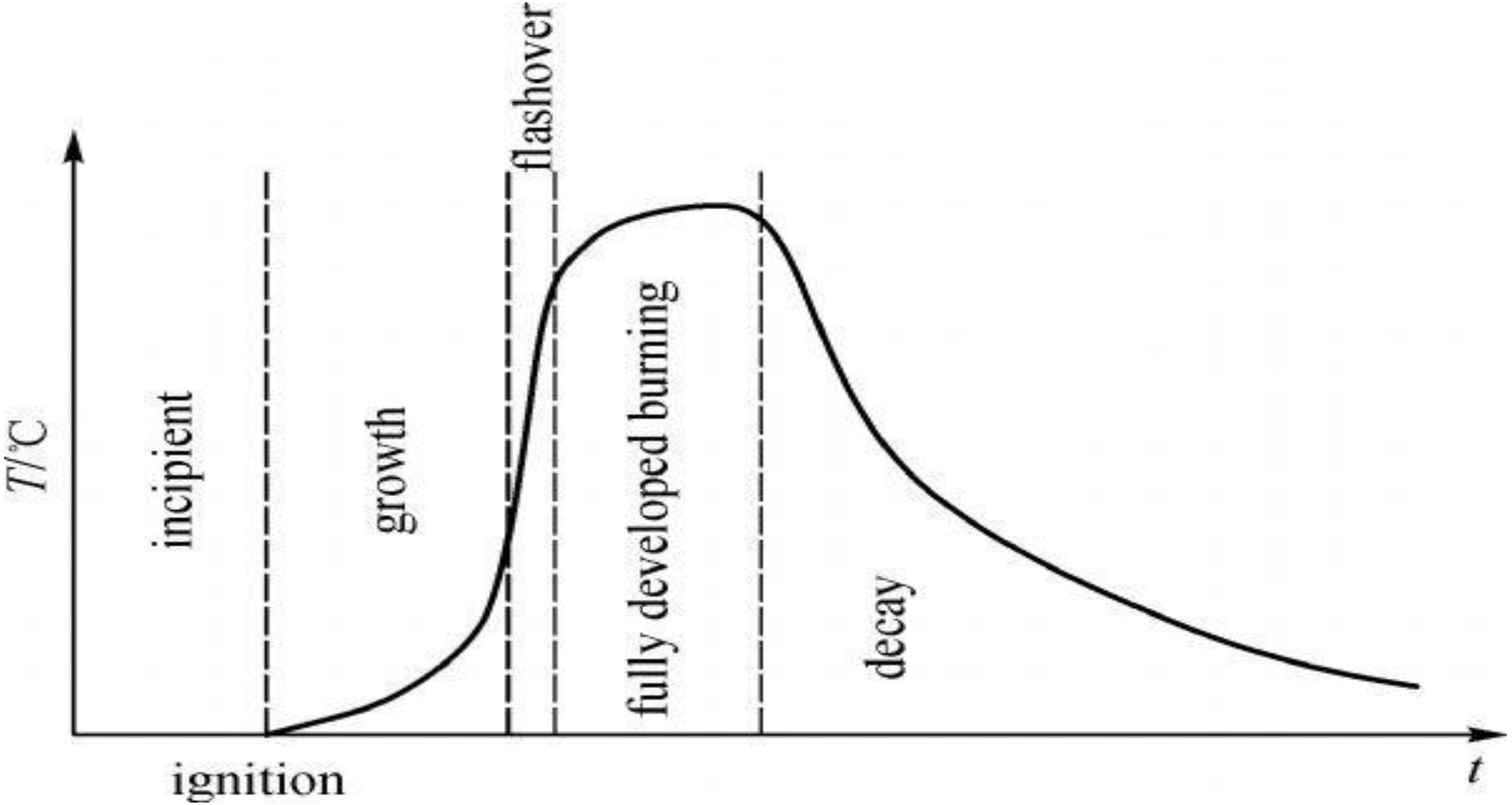
Results impression tests

- Products can resist a smouldering cigarette
- Products ignite when a small open flame or crib 5 is used as ignition source
- Temperature is high enough to, in case of enough oxygen, cause a flashover
- As soon as the objects ignite, temperature is the defining parameter for the possibility of escape as well as the chance of survival

Relevante brandscenario's (NFPA)

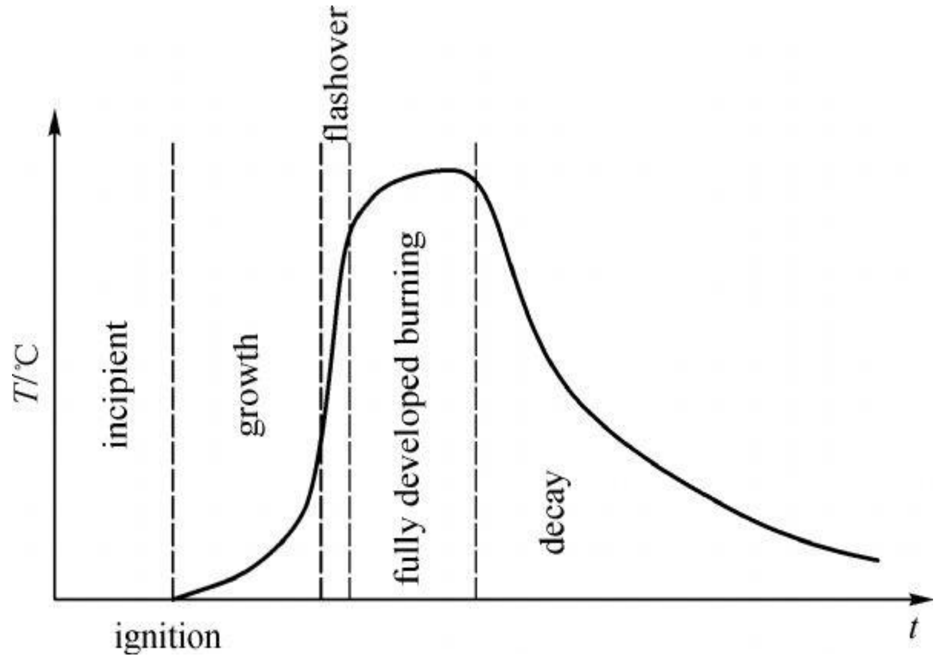
1. **Cigaret ignition scenario:** smoldering ignition by burning tobacco product
2. **Open flame ignition scenario:** ignition by an open flame from another fire, where the furniture or mattress makes the largest contribution to the fire spread, but is not the first object that burns
3. **Ignition scenario due to arson or heat-generating equipment**
4. **Small open flame ignition scenario:** ignition by candle, match or lighter
5. **Smoldering ignition scenario:** ignition by smoldering object

Fire stages

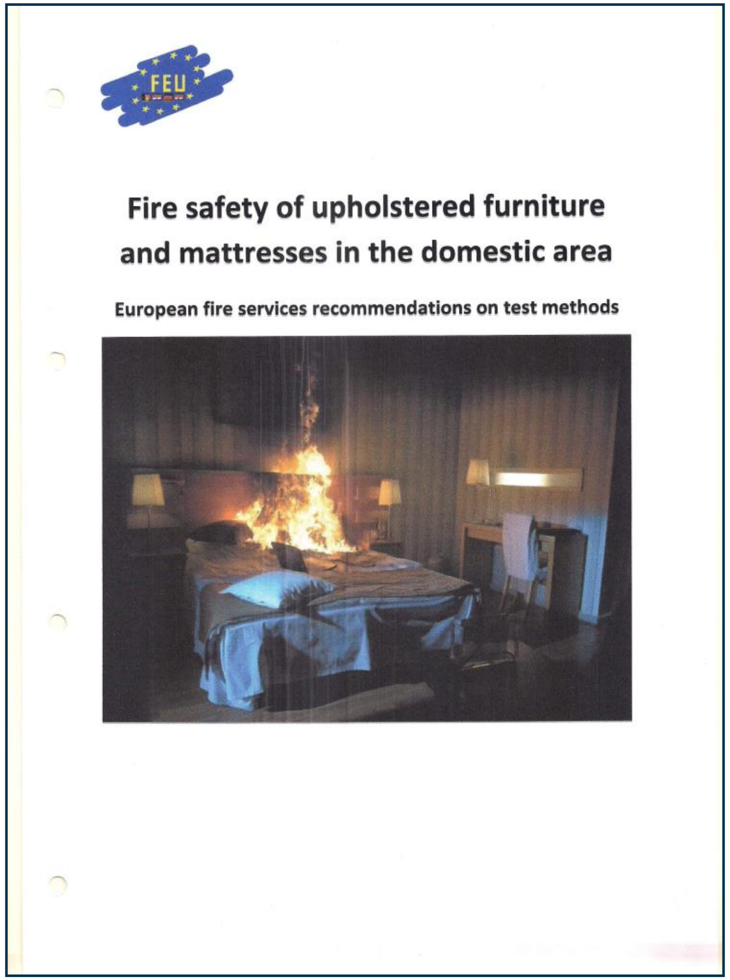

flashover
T/℃
incipient
growth
fully developed burning
decay
ignition
t

Conclusions/recommendations

- Both phase 1 and phase 2 contribute to the chances of survival
- In phase 2, other factors that cannot be tested play a role (ventilation, location of object in room)
- Focus is on phase 1: prevent ignition **of the foam filling**



Result research in report, leaflet and article



Distribution of FEU research *Fire safety of upholstered furniture and mattresses in the domestic area*

It is estimated that every year 1000 people are killed in the European Union in a residential fire where the flammability and smoke production of upholstered furniture and mattresses were decisive for the fatal consequence of the fire. For the FEU, this was the reason to start an investigation about this matter. The results are presented in the report Fire safety of upholstered furniture and mattresses in the domestic area.

Attention to broader target group

The research appears to provide a turning point in thinking about the possibilities and impossibilities of realizing fire-safe furniture and mattresses. It also provides a strong impulse for finding solid solutions for this important fire safety problem. In order to reinforce this development, it is necessary to bring the research to the attention of a broader target group.
It has therefore been agreed that all members of the FEU will actively communicate about the research in their country.

Article with summary of the report

You can use the article Fire-study to increase the fire safety of furniture, which is a summary of the research, for dissemination. This article can be found on the attached USB stick and is available in English, German, French and Dutch. The complete report and the test report Impression tests upholstered furniture and mattresses belonging to the report, can also be found on the USB stick. If you require the article in a different language, you can translate it to the preferred language.

Target groups and communication channels

We were thinking about the following target groups: legislators, policy makers, standardization institutes, consumers and producers and suppliers of furniture and mattresses.
Possible channels that can be used for dissemination are your own website (s) and social media. Additionally, we advise you to generate free publicity through relevant external websites, trade media and general media.

Questions?

If you have any questions about the research, you can consult the flyer with Q & A's.

Verspreiding FEU-onderzoek *Fire safety of upholstered furniture and mattresses in the domestic area*

Naar schatting komen in de Europese Unie jaarlijks 1000 mensen om het leven bij een woningbrand waarbij de brandbaarheid en rookproductie van bekleed meubilair en matrassen doorslaggevend waren voor het fatale gevolg van de brand. Dit was voor de FEU reden om hiernaar een onderzoek te starten. De resultaten zijn gepresenteerd in het rapport Fire safety of upholstered furniture and mattresses in the domestic area.

Aandacht bij bredere doelgroep

Het onderzoek blijkt te zorgen voor een kentering in het denken over de mogelijkheden en onmogelijkheden van het realiseren van brandveiliger bekleed meubilair en matrassen. Ook geeft het een stevige impuls aan het vinden van solide oplossingen voor dit belangrijke brandveiligheidsprobleem. Om deze ontwikkeling kracht bij te zetten, is het noodzakelijk om het onderzoek bij een bredere doelgroep onder de aandacht te brengen. Afgesproken is dan ook dat alle leden van de FEU in hun land actief gaan communiceren over het onderzoek.

Artikel met samenvatting van rapport

U kunt hiervoor gebruikmaken van het artikel Brandweerstudie wil brandveiligheid van meubels vergroten, dat een samenvatting is van het onderzoek. Dit artikel staat op de bijgevoegde usb-stick en is beschikbaar in het Engels, Duits, Frans en Nederlands. Ook het rapport zelf en het bij het rapport behorende testrapport Impression tests upholstered furniture and mattresses staan op de usb-stick. Heeft u het artikel in een andere taal nodig, dan kunt u het uiteraard laten vertalen.

Doelgroepen en communicatiekanalen

Qua doelgroepen denken we aan: wetgevers, beleidsmakers, normalisatie-instituten, producenten en leveranciers van meubilair en matrassen, en consumenten.
Mogelijke kanalen zijn uw eigen website(s) en social media. Verder adviseren wij u om free publicity te genereren via relevante externe websites, vakmedia en algemene media.

Vragen?

Raadpleeg voor vragen over het onderzoek de flyer met Q&A's.

Recommandations ignition sources

By **preventing ignition of the foam** of upholstered furniture and mattresses, the survivability and possibility of escape from dwelling fires will increase. Domestic furniture and mattresses should be able to prevent this ignition with different ignition sources on the end-use-product:

Cigarette ignition test. This is the most important because it covers the most common ignition scenario's
Ignition by a small open flame. This is also important because it covers more ignition scenarios than those covered by the cigarette test
Open flame ignition by a wooden crib. This covers larger ignition scenarios than the small open flame test

Performance of the end-use product

By introducing requirements to prevent ignition of upholstered furniture and mattresses, the focus must be on preventing **the foam filling to ignite** (or burn very slowly).

The current regulations (e.g. USA, UK, Russia) are to much focused on the testing of components (even in end-use situation). That blocks innovative solutions s.a. interliners and alternatives for foam fillings.

Conclusion and advise

Don’t focus on the behavior of the components but look at the performance of the end-use-product and prevent foam fillings to catch fire.

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Thank you for your attention!

Comparison of country furniture standards using corner burns, fire spread & smoke toxicity

Matthew Blais

Director of Fire Technology, Southwest Research Institute (SWRI)

Comparison of Country Furniture Standards Using Room Corner Burns

Fire Spread and Smoke Toxicity

Dr. Matthew S. Blais

Department of Fire Technology

Southwest Research Institute

Outline

- Introduction and Background
- Hypothesis
- Experimental
- Heat Release and Smoke Generation Results
- Smoke Timing and Chemistry
- Smoke Acute Toxicity
- Conclusions

Introduction

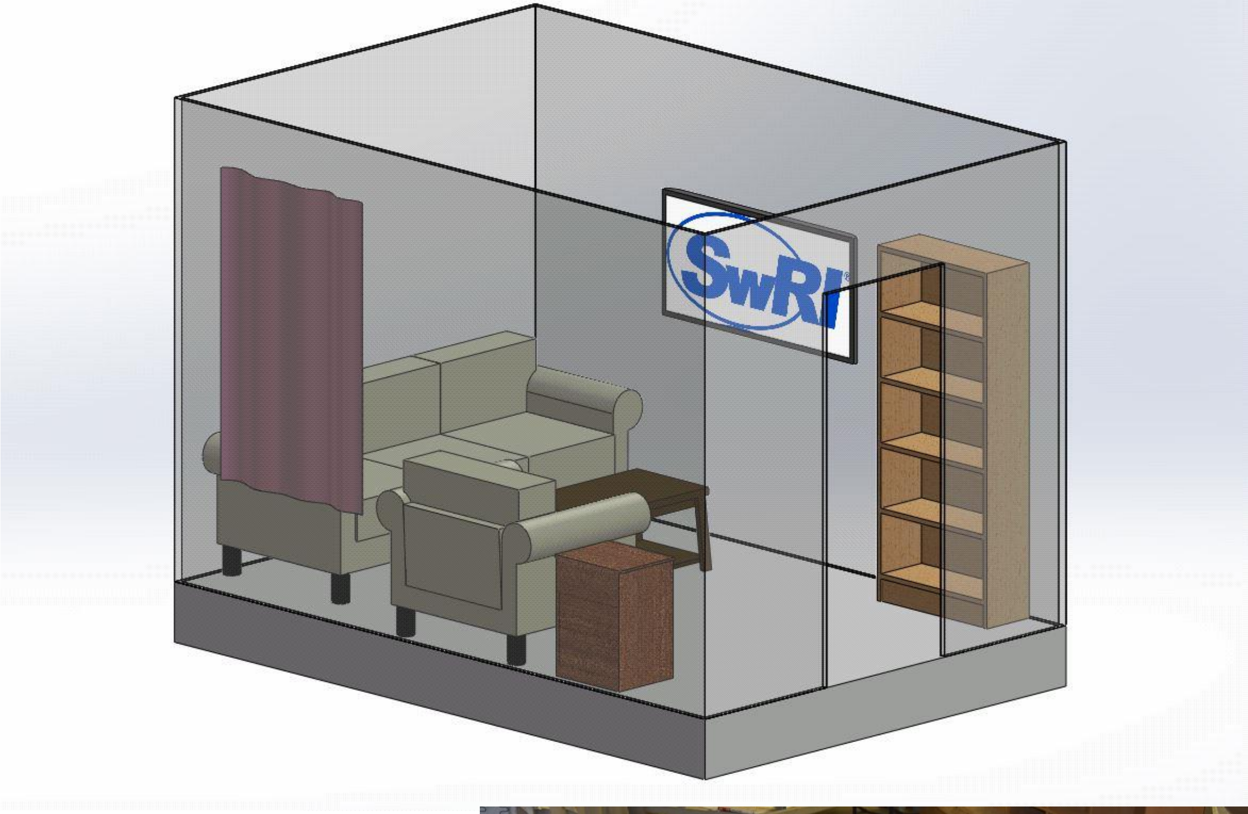
- Controversy over Fire Retardants and whether they are effective or needed
- Controversy over the quantity and toxicity of smoke for FR protected furnishings
- Controversy related to the blooming of FR and environmental exposure in the home
- Controversy over open flame ignition requirement in standards
- This study is designed to provide data that will add to the discussion.
- Comparison of US standards (Cal TB117,smoulder only) French Standards (EN 1021-1, inflammable covering, smoulder only) and English (BS 5852 crib 5, open flame)

Hypothesis

- H1 - Country fire codes for furniture and Electrical Equipment affect their performance in fires
- H2 - Smoke is more acutely toxic from furniture containing fire retardants
- H3 - Fire retardant materials produce more smoke

Experimental

- ISO 9705 Rooms
- Furnished with:
  - 3 cushion couch, chair, Flat Panel television 55 inch, coffee table, book case w/20 lbs of books, curtains and end table
  - All pieces identical for each room except country of origin (England France, US)
  - Focus Couches, chairs and televisions
  - Room arranged exactly the same within ±1.0 cm



Experimental

- Ignition source from BS 5852:
  - Crib 4 ≈ 125 W
  - Crib 5 ~ 250 W
  - Crib 6 ~ 900 W
- Crib Placement
- Analytical
  - Oxygen consumption Calorimeter
  - Smoke – light path obscuration-dispersion
  - Video evidence - Infra-Red and HD

Experimental

- Analytical Cont.
  - PAH sampling – XAD cartridge
  - Chloro and Bromo Dioxin/Furans – XAD cartridge
  - SVOC – XAD cartridge
  - VOC – Summa Cannister
  - Total Smoke Impingers (for latter studies)
  - Sampling at 2 SLPM for 2 min
  - Acid and Narcotic gasses – FTIR scanned every 9 seconds
  - Sampling location: center room at 0.5 m and 10 cm below door frame.

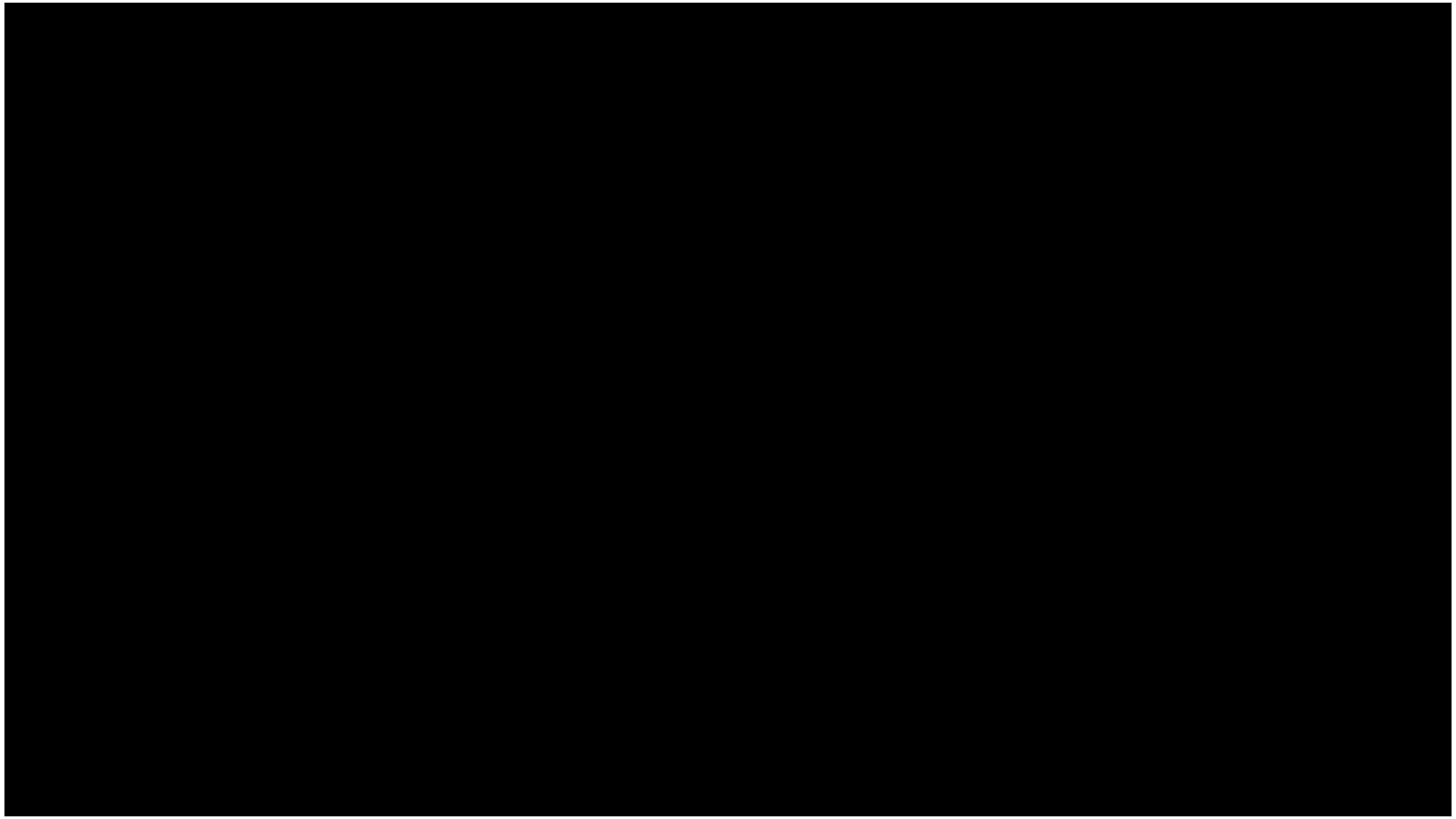
Experimental

- Total of 9 room burns
  - 3 of each country source
  - 1 of each country ignited with crib 4, 5 and 6
  - All ignited on the central cushion in contact with the back cushion

Experimental

- Analytical collection sequence
  - FTIR, total smoke, HRR, Smoke opacity – continuous over duration of fire
  - Crib 4 test of all 3 configurations - continuous over duration of fire
  - Crib 5 and 6 – sample collected during white smoke period. Sample collected during black smoke period.

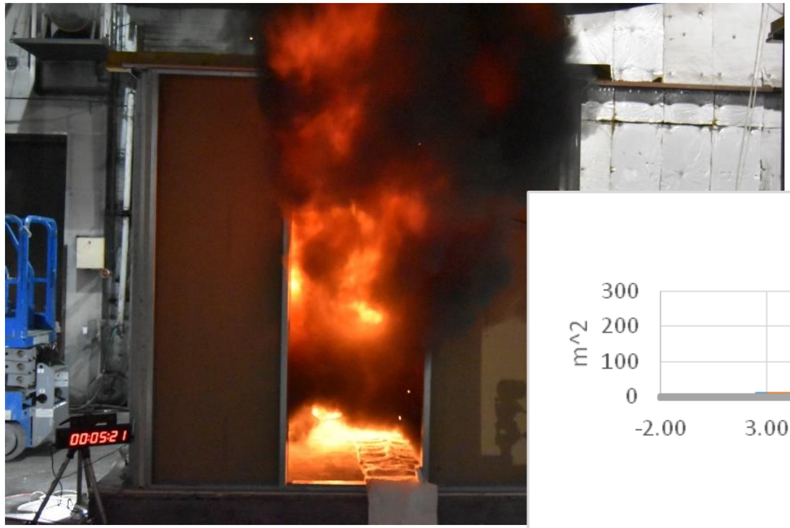
Comparative Burn Crib 4 Ignition all Three Countries

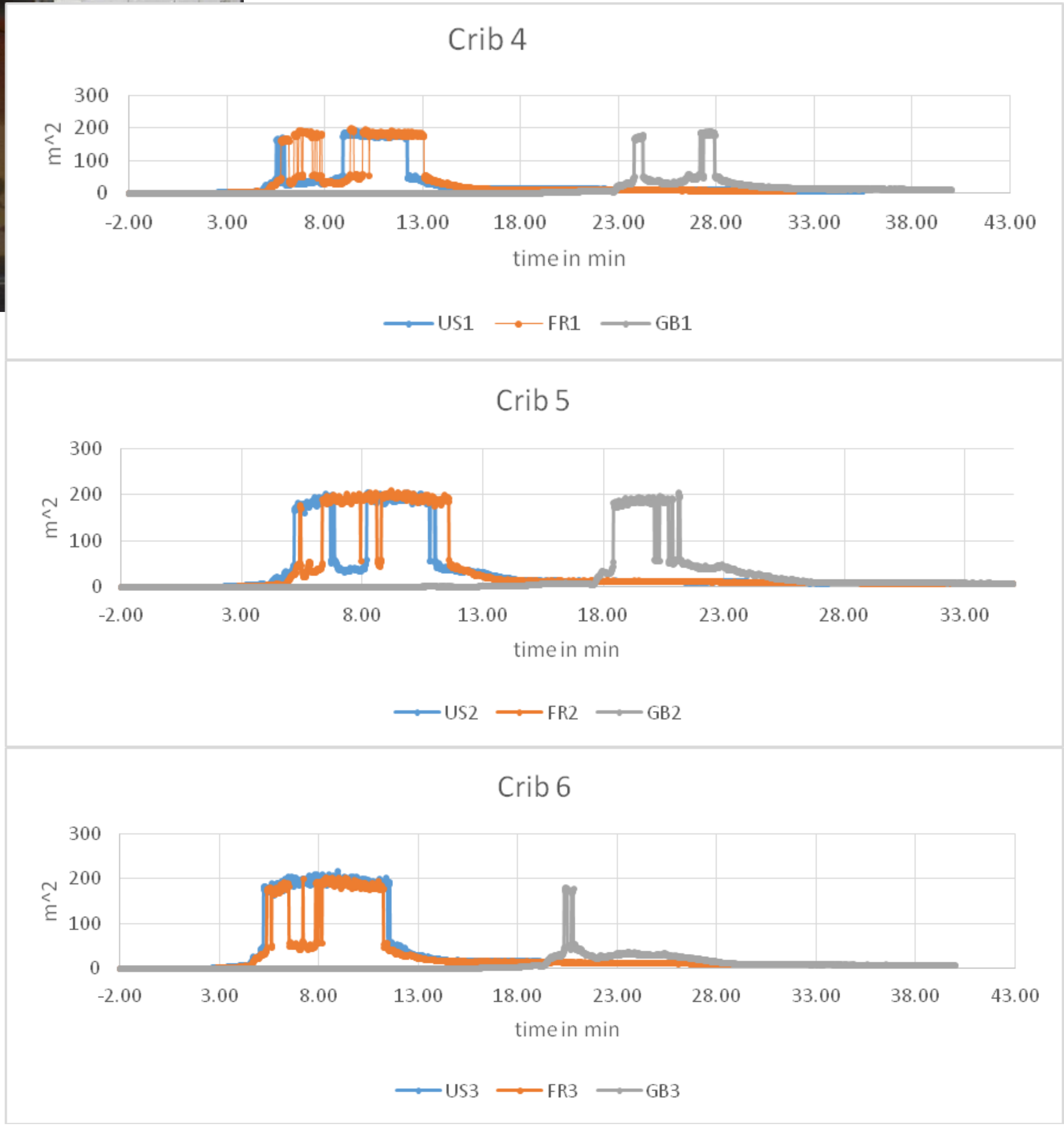


Heat Release Rate

- Ignition starts at time zero, plots show 2 min baseline measurements as -2.00 min to time zero.
- Time to Flashover significantly and repeatedly delayed for English furnishings, 17 to 22 min
- US and French furnishings reach flashover very quickly, 4 to 5 min.

Smoke Production





- Opacity is significantly delayed in English furnishing and of shorter duration
- French and US furnishings virtually identical and very quick under all three ignition conditions

HRR and Smoke DATA

- French furnishings had highest heat and smoke number but was closely followed by the US
- English furnishings produced half the total smoke, lower pHRR and >4X longer times to Flashover
- English Furnishing reached flashover with crib 4 and 5 which was unexpected

Summary Smoke and Heat Data from all 9 Tests

Test	pHRR kW	time to pHRR	Total heat MJ	Max Smoke m^2/s	time to Max Smoke	total Smoke m^2	pHeat Flux at floor kW/m^2	time to peak heat flux min:s	Flashover min:s
US1	2890	6:24	2134	191.5	9:36	62975	---------	---------	5:00
US2	2922	7:49	2107	204.6	9:54	70517	121.1	13:23	5:00
US3	2811	6:21	1800	216.1	9:00	85362	220.3	10:56	4:20
US Average	**2874**	**6:51**	**2014**	**204.1**	**9:30**	**72951**	**170.7**	**12:09**	**4:46**
GB1	2690	24:19	1892	189	27:44	33734	---------	---------	22:37
GB2	2822	21:09	1899	204.1	21:09	45196	221.5	23:28	17:10
GB3	2499	21:00	1909	181	20:25	24061	122.2	24:08	19:07
GB Average	**2670**	**21:04**	**1900**	**191.4**	**21:09**	**34330**	**171.8**	**23:28**	**19:38**
FR1	2941	6:29	2300	197.6	9:22	72561	117.1	14:47	5:00
FR2	3307	5:56	2278	209.3	9:11	79664	199.1	11:19	4:49
FR3	2848	7:34	2011	202.8	8:20	72101	219.1	10:32	5:00
Fr Average	**3032**	**6:39**	**2196**	**203.2**	**8:57**	**74775**	**178.4**	**12:12**	**4.:56**

Smoke Characteristics

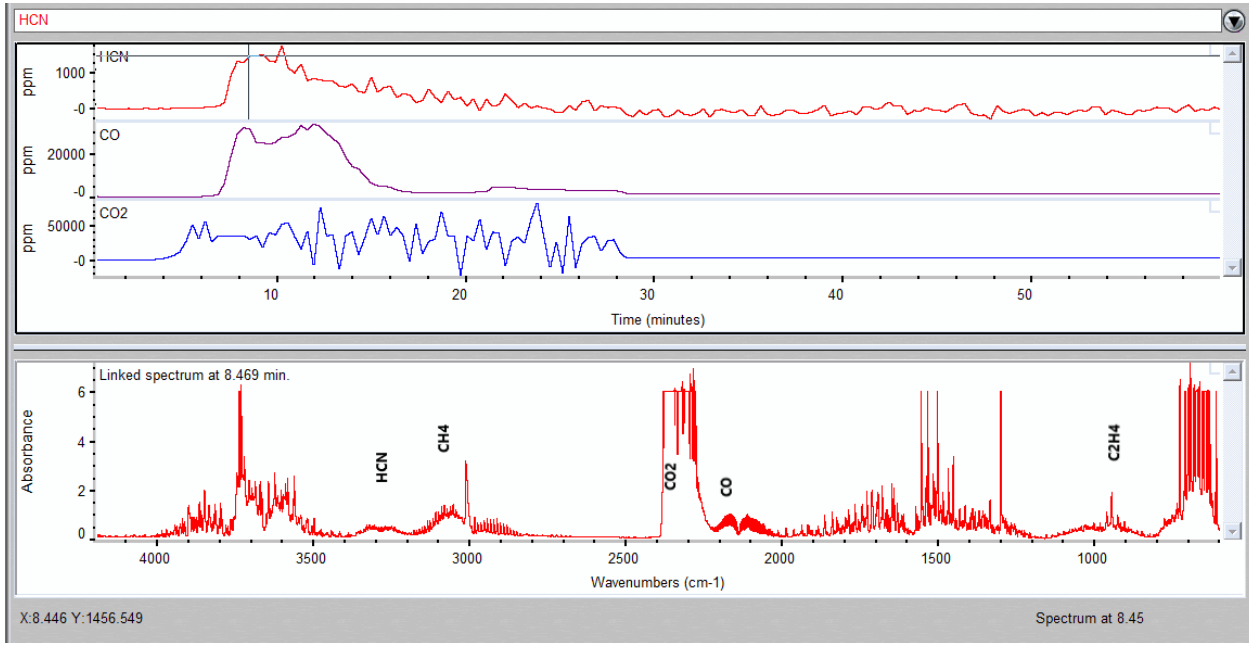
- Time to transition of white or light smoke to heavy black smoke
  - English occurs at 17 to 19 minutes
  - French occurs 3 to 4 minutes
  - US occurs 3 to 4 minutes
- White and black smoke separately characterized for 6 of 9 trials.

Smoke Analysis - FTIR

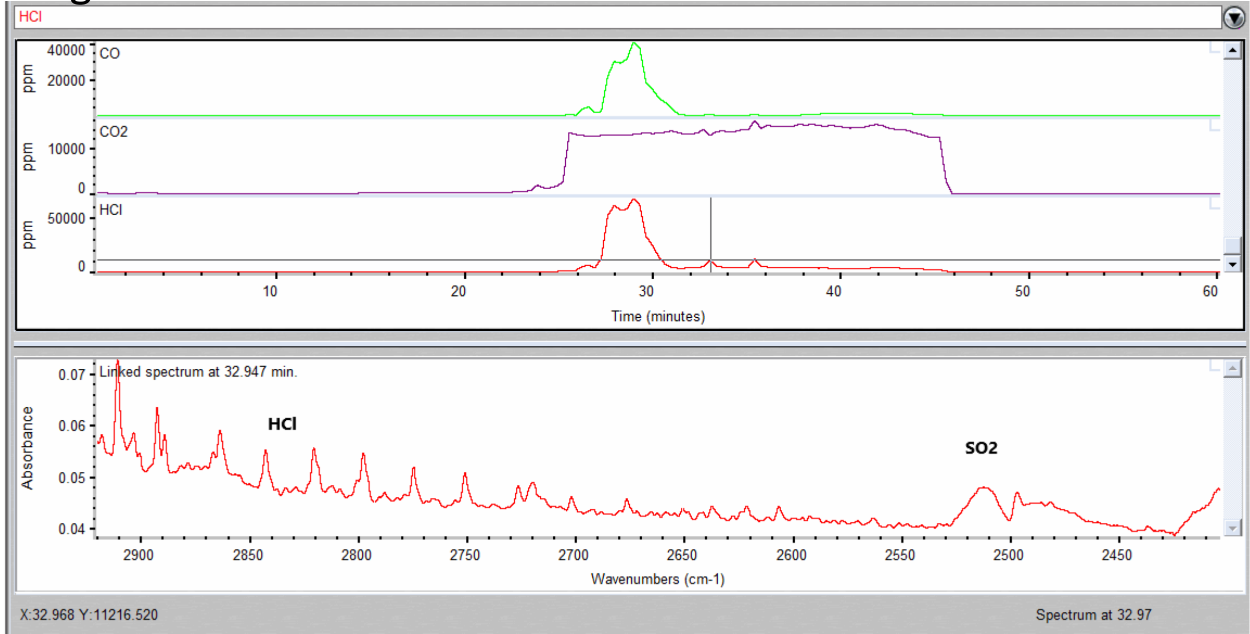
Chemical	GB cent Rm	GB Door	FR Cent Rm	FR Door	US Cent Rm	US Door
HCN	ND	**1029 ppm 21.1 min**	ND	**1234 ppm 6.1 min**	ND	**1600 ppm 6.0 min**
SO_2	510 ppm 29.9 min	646 ppm 29.9 min	588 ppm 13.9 min	2300 ppm 13.5 min	639 ppm 13.5 min	3300 ppm 13.2 min
CO	**18,200 ppm 23.9 min**	**18,000 ppm 23.0 min**	**31000 ppm 12.2 min**	**28000 ppm 6.2 min**	**60800 ppm 8.2 min**	**38200 ppm 8.8 min**
NH_3	ND	ND	ND	**2500 ppm 8.0 min**	ND	**2743 ppm 8.4 min**
Methane	1094 ppm 23.7 min	1703 ppm 23.3 min	1334 ppm 9.7 min	31815 ppm 8.0 min	1426 ppm 10.1 min	1928 ppm 7.8 min
Ethylene	378 ppm 23.7 min	818 ppm 23.3 min	693 ppm 9.4 min	1887 ppm 8.0 min	993 ppm 9.8 min	2033 ppm 7.8 min
CO_2	13330 ppm 23.7 min	87930 ppm 27.4 min	12480 ppm 7.8 min	33600 ppm 11.1 min	14700 ppm 9.9 min	95200 ppm 15.2 min
H_2O	19310 ppm 24.0 min	82270 ppm 25.4 min	17510 ppm 9.9 min	79100 ppm 11.3 min	28500 ppm 9.9 min	76900 ppm 11.9 min
HCl	65 ppm 23.9 min	ND	ND	ND	ND	ND

- FTIR shows French Test gets acutely toxic very quickly, starting at 6 min and ending at 12 min, CO and HCN
- English test #1 acute toxicity significantly delayed, starting at 21 min, lower than both US and French
- HCl false positive due to high hydrocarbons, but detected at low levels at 32 min in the English test #1
- SO2 detection for all rooms late in the fire from wood combustion

French test #1



English test #1



Smoke Analysis VOC

Chemical Name/ppb v/v	GB1	GB2	GB3	GB1 Flashover	GB2 Flashover	GB3 Flashover	US1	US2	US3	US1 Flashover	US2 Flashover	US3 Flashover	FR1	FR2	FR3	FR1 Flashover	FR2 Flashover	FR3 Flashover
PROPENE	480	224	226 DL	3950 DL	1060	204	313	182	10.8	6640 DL	37800 DL	1150 DL	115	173	202 DL	53900 DL	380	4200 DL
CHLOROMETHANE	2.85	ND	46 dl	ND	240	88	145	ND	0.941	ND	1680 DL	ND	ND	ND	41.9	13400DL	ND	1850 DL
VINYL CHLORIDE	0.612	ND	3.46	ND	68.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	90	23.2	1.74
1,3-BUTADIENE	61.2 DL	58.7	58 DL	ND	ND	38.8	ND	28.6	1.01	ND	ND	ND	21.7	39.2	38.4	6610 DL	ND	2130 DL
BROMOMETHANE	ND	ND	12	21.2	ND	ND	ND	ND	ND	ND	136	19.2	ND	ND	31.4	362	13.8	4.58
ETHANOL	99 DL	45.4	13.2	ND	170 DL	ND	ND	ND	ND	ND	231	ND	3880 DL	19.3	23	ND	716 DL	14.6
ACROLEIN	**593**	**176**	**128**	**609 DL**	**1360**	**ND**	**561**	**70.8**	**ND**	**966**	**7720**	**1350**	**ND**	**64.7**	**118 Dl**	**6990**	**196**	**ND**
ACETONE	267	104	70.5	843 DL	842 DL	524 DL	420DL	94.1	25.7	953 DL	4450	1420	78.3	55.8	150 DL	74500 DL	849 DL	1500 DL
ISOPROPANOL	161	519	311 DL	6850 DL	413	ND	396 DL	2820	35.6	3160 DL	1150 Dl	1200	717000 DL	510	1180 DL	1090000 DL	791 Dl	3290 DL
CARBON DISULFIDE	ND	ND	3.87	209 DL	23.4	ND	77.6 DL	ND	ND	39.3	777 DL	591	ND	ND	ND	232	466 DL	5.14
VINYL ACETATE	ND	44.2	ND	ND	222	ND	80.7	ND	ND	54.4	ND	224	ND	ND	ND	ND	ND	ND
2-BUTANONE	241	55	40.4	ND	129	ND	19.4	3.65	4.42	21.8	377	52	ND	4.11	7.21	ND	ND	ND
BENZENE	**982**	**257**	**164**	**71000 DL**	**10100 DL**	**33500 DL**	**9610**	**841**	**20.9**	**36300 DL**	**50300 DL**	**10800**	**2860 DL**	**1750**	**4350 DL**	**140000DL**	**17700 DL**	**512000 DL**
1,2-DICHLOROPROPANE	ND	ND	2.69	ND	27.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-DIOXANE	52.3Dl	9.43	4.97	ND	15.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHYL METHACRYLATE	2.29	ND	ND	625 DL	1850 DL	ND	621 DL	ND	ND	883 DL	3320 DL	2080	ND	ND	ND	123	2960 DL	2220 DL
TOLUENE	**95.9 DL**	**30.7**	**12.9**	**1960 DL**	**472**	**122**	**383**	**39.9**	**2.19**	**1560 DL**	**3370 DL**	**307**	**23.9**	**89.9**	**101**	**32800 DL**	**318**	**9790 DL**
CHLOROBENZENE	ND	ND	1.5	ND	ND	ND	ND	ND	ND	17.4	53.5	ND	ND	ND	ND	132	51	6.13
ETHYLBENZENE	15.6 DL	3.69	ND	20.6	31.9	ND	18.6	5.42	0.971	138	952	13.9	ND	8	4.66	1040	ND	7.82
M/P-XYLENE	13.7 DL	3.33	ND	19.8	19	ND	ND	ND	3.27	101	565	13.8	ND	3.34	3.94	1020	ND	40.9
STYRENE	21.5	8.34	ND	28.1	50.1	53.2	47.9	23.7	0.906	34.7	499	ND	ND	44.6	42.7	2060	ND	2700 DL
O-XYLENE	4.13	ND	ND	ND	ND	ND	ND	ND	1.06	66.2	199	ND	ND	ND	ND	418	ND	14.4
NAPHTHALENE	288	18.7	15.1	271	146 DL	2260	1340	136	10.5	295 DL	2420 DL	3570	39.3	69.4	16400 DL	47200 DL	469	4800 DL

- Units of measurement are ppb v/v
- All of the white smoke measurements have very low levels, post flashover-black smoke much higher levels
- Monomers prevalent, fragment of FR, aromatic and PAH
- Acrolein higher in non fire resistant systems

Smoke Analysis SVOC / PAH

Sample ID	GB2 SVOC White	GB3 SVOC White	GB2 SVOC Black	GB3 SVOC Black
Compound	micrograms/m^3	micrograms/m^3	micrograms/m^3	micrograms/m^3
Phenol	ND	421	500	155
Naphthalene	ND	1684	10400	6667
2-Methylnaphthalene	ND	ND	106	ND
Acenaphthylene	ND	189	**1800**	**1176**
Dibenzofuran	ND	ND	**78**	ND
Fluorene	ND	ND	**68**	ND
Phenanthrene	ND	ND	**520**	**145**
Anthracene	ND	ND	**62**	ND
Fluoranthene	ND	ND	**194**	**67**
Pyrene	ND	ND	**260**	**143**
Acetophenone	ND	97	**174**	**63**

Sample ID	US2 SVOC White	US3 SVOC White	US2 SVOC black	US3 SVOC Black *
Compound	micrograms/m^3	micrograms/m^3	micrograms/m^3	micrograms/m^3
Pyridine	ND	ND	949	471
Phenol	ND	590	385	276
Naphthalene	ND	6800	**69231**	16176
2-Methylnaphthalene	ND	ND	**1256**	106
Acenaphthylene	ND	460	**4615**	824
Dibenzofuran	ND	ND	**564**	126
Fluorene	ND	ND	**410**	ND
Phenanthrene	ND	ND	**2821**	ND
Anthracene	ND	ND	**513**	ND
Fluoranthene	ND	ND	**1103**	ND
Pyrene	ND	ND	**1179**	ND
Benzo[a]anthracene	ND	ND	**190**	ND
Chrysene	ND	ND	**241**	ND
Benzo(b)fluoranthene	ND	ND	**231**	ND
Benzo[a]pyrene	ND	ND	**238**	ND
Indeno[1,2,3-cd]pyrene	ND	ND	**156**	ND
Benzo[g,h,i]perylene	ND	ND	**185**	ND

Smoke Analysis - SVOC

Sample ID	FR2 SVOC Black	FR3 SVOC black	FR2 SVOC White	FR3 SVOC White*
Compound	micrograms/m^3	micrograms/m^3	micrograms/m^3	micrograms/m^3
Pyridine	3167	767	ND	1438
Aniline	400	ND	ND	171
Phenol	4833	6333	ND	375
m-cresol & p-cresol	317	533	ND	-
Naphthalene	**141667**	**18333**	173	35417
2-Methylnaphthalene	**1917**	**500**	ND	396
Acenaphthylene	**16667**	**3500**	ND	2500
Dibenzofuran	**492**	ND	ND	229
Fluorene	**700**	ND	ND	185
Phenanthrene	**4500**	**2000**	ND	1854
Anthracene	**700**	**ND**	ND	333
Fluoranthene	**1667**	**2000**	ND	875
Pyrene	**1917**	**2167**	ND	1104
Benzo[a]anthracene	**208**	**600**	ND	115
Chrysene	**242**	**717**	ND	156
Benzo(b)fluoranthene	**292**	**867**	ND	138
Benzo[a]pyrene	**342**	**750**	ND	125
Indeno[1,2,3-cd]pyrene	**233**	**600**	ND	73
Benzo[g,h,i]perylene	**292**	**583**	ND	110
Acetophenone	267	- ND	ND	ND

- English Furnishings – lower molecular weight and lower concentration of PAH
- French Furnishings had the highest quantities of more toxic PAH in the black smoke, FR3 transition to black smoke was very fast causing the FR3 white sample to capture some black smoke.
- US3 suffered a line blockage during the black smoke collection giving lower concentration of Fewer PAH.

Smoke Analysis –Chloro Dioxin/Furan

Compound	18-311 FR1 Dioxin total		18-313 FR2 Dioxin White Smoke		18-317-GB2 Dioxin Black Smoke		18-319-FR3 Dioxin White Smoke	
	Conc. (Tot. pg)	Qual	Conc. (Tot. pg)	Qual	Conc. (Tot. pg)	Qual	Conc. (Tot. pg)	Qual
2,3,7,8-TCDD	ND	ND	**20.7**	ND	ND	ND	ND	ND
1,2,3,7,8-PeCDD	ND	ND	**4.02**	J	ND	ND	ND	ND
1,2,3,7,8,9-HxCDD	ND	ND	**12.7**	J	ND	ND	ND	ND
1,2,3,4,6,7,8-HpCDD	8.71	J	**9.76**	J	ND	ND	ND	ND
OCDD	26.2	J	**11.1**	J	ND	ND	23.1	J
2,3,7,8-TCDF	ND	ND	**6.02**	J	5.63	J	ND	ND
1,2,3,7,8,9-HxCDF	ND	ND	**2.85**	J	ND	ND	ND	ND
2,3,4,6,7,8-HxCDF	ND	ND	**3.36**	J	ND	ND	ND	ND
1,2,3,4,6,7,8-HpCDF	ND	ND	**7.43**	J	ND	ND	7.45	J
1,2,3,4,7,8,9-HpCDF	ND	ND	**10.6**	J	ND	ND	9.70	J
OCDF	ND	ND	**15.2**	J	ND	ND	22.3	J

Smoke Analysis –Bromo Dioxin/Furan

	18-317- GB2 DIOXIN BLACK		18-317- GB2 DIOXIN WHITE		18-317- GB3 DIOXIN BLACK		18-317- GB3 DIOXIN WHITE	
Total pg	Conc	Qual	Conc	Qual	Conc	Qual	Conc	Qual
123478/123678-HxBDD	4.02	J	ND	ND	4.1	J	ND	ND
1234678-HpBDD	12.2	J	ND	ND	10.6	J	ND	ND
OBDD	ND	ND	ND	ND	ND	ND	ND	ND
2468-TBDF	ND	ND	ND	ND	ND	ND	ND	ND
23478-PeBDF	ND	ND	1.752	J	ND	ND	ND	ND
123478-HxBDF	4.54	J	ND	ND	ND	ND	ND	ND
1234678-HpBDF	15.96		8.6	J	ND	ND	4.84	J

	118-317-US3 DIOXIN WHITE		18-310-US2 DIOXIN BLACK		18-310-US1 DIOXIN		18-317- US3 DIOXIN BLACK	
Total pg	Conc	Qual	Conc	Qual	Conc	Qual	Conc	Qual
123478/123678-HxBDD	ND	ND	ND	ND	ND	ND	ND	ND
1234678-HpBDD	8.98	J	11.66	J	11.56	J	ND	ND
OBDD	ND	ND	ND	ND	ND	ND	ND	ND
2468-TBDF	ND	ND	ND	ND	1.012	J	ND	ND
23478-PeBDF	ND	ND	ND	ND	ND	ND	ND	ND
123478-HxBDF	3.78	J	3.48	J	ND	ND	ND	ND
1234678-HpBDF	7.82	J	ND	ND	ND	ND	6.66	J

=	18-313 FR2 DIOXIN LIGHT SMOKE		18-313 FR2 DIOXIN Black Smoke	
Total pg	Conc	Qual	Conc	Qual
123478/123678-HxBDD	ND	ND	ND	ND
1234678-HpBDD	7.48	J	ND	ND
OBDD	ND	ND	ND	ND
2468-TBDF	ND	ND	1.26	J
23478-PeBDF	ND	ND	ND	ND
123478-HxBDF	ND	ND	ND	ND
1234678-HpBDF	3.42	J	5.02	J

Conclusions

H1 - Country fire codes for furniture and Electrical Equipment affect their performance in fires: the furniture standard in England (BS5852) is significantly more protective than that in the US or France. Escape time is significantly increased, >4X. Performance of French and US furnishings are approximately the same with very short flashover times resulting from a small open flame ignition source.

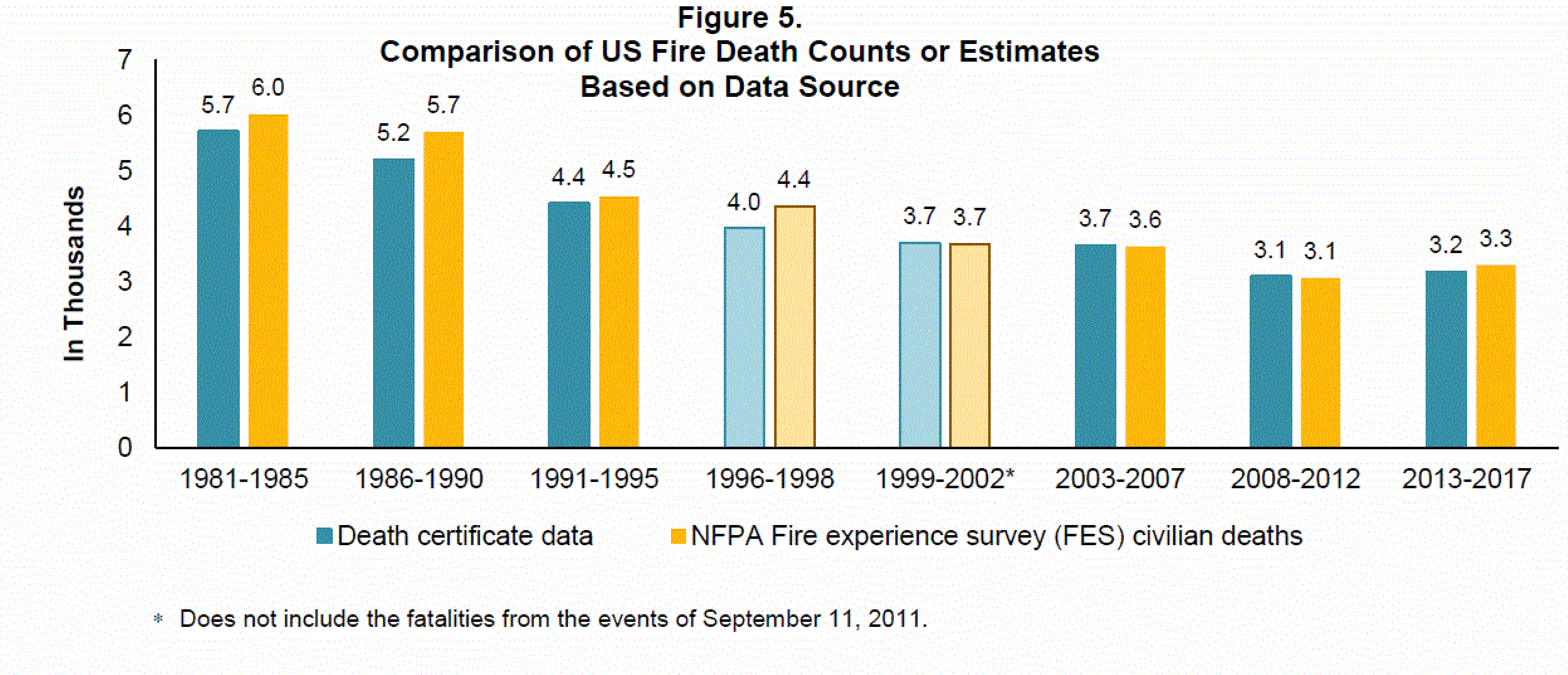
H2 - Smoke is more acutely toxic from furnishing containing fire retardants: this hypothesis is false, the smoke generated in the French and US furnishing which did not indicate FR produced more and more acutely toxic smoke then the English furnishing as seen in the CO HCN concentration profiles. Chronic toxicity was evaluated in this study but smoke samples were collected and saved for a follow-on toxicity study.

H3 - Fire retardant materials produce more smoke: this hypothesis is false, the more highly protected English furnishings produced less than half of the smoke produced for te French and US furnishings. Both the heat and smoke production were also significantly delayed. Multiple replicates of the each furnishing configuration were tested with increasing ignition energy. The results were very consistent within each country source.

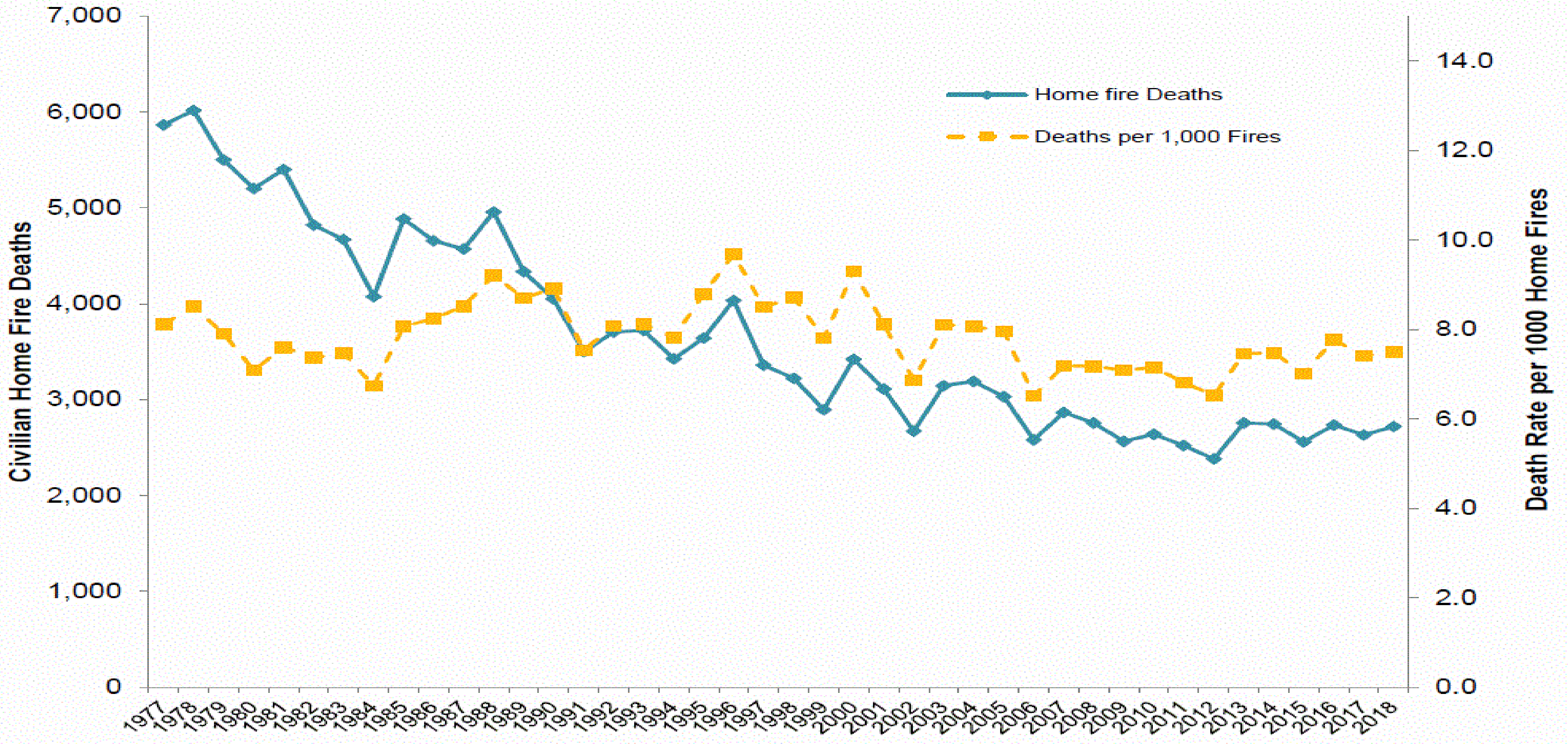
Ignoring or eliminating open flame ignition sources from furniture and electronics equipment decreases their safety by reducing their resistance to ignition.

Note: Crib 5 appears to present a bigger ignition threat in this scenario then crib 6 possibly due to geometry

Impact of Fire Code Change in US



Impact of Fire Code Change in US



Source: NFPA Survey of Fire Departments (1977-2018)

Uniting fire safety, health and circular agendas

Pär Stenmark

Chief Regulatory Affairs Officer, IKEA Range & Supply

Uniting fire safety, health, and circular agendas

Pär Stenmark, Chief Regulatory Affairs Officer
IKEA Range & Supply

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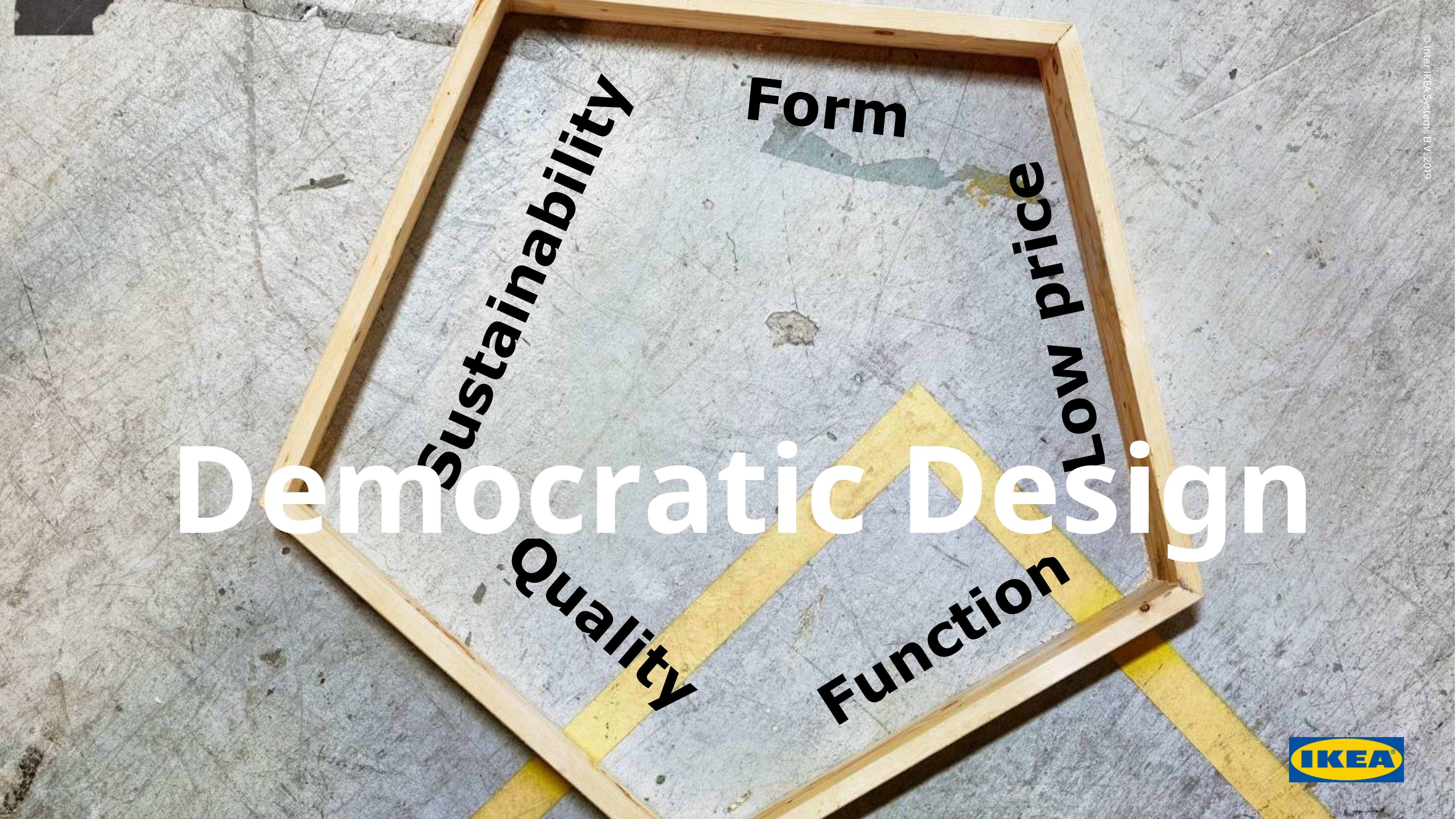
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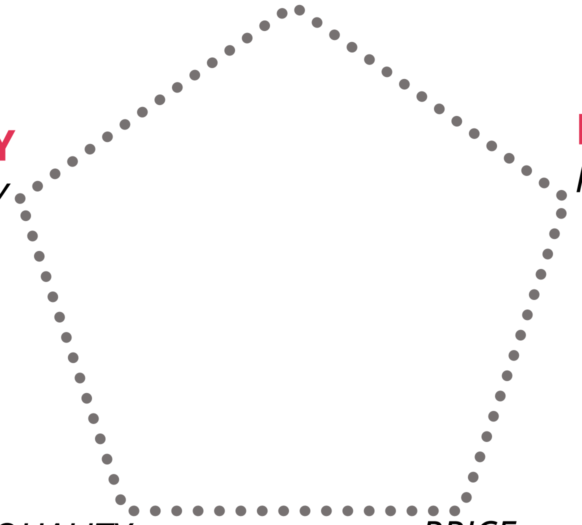


Fire
safety
Chemical
safety
Circularity

Case study: SKUMMESLÖV


Most things still remain to be done.
A glorious future!
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Coffee Break

Panel discussion and Q&A

Guillermo Rein
Professor of Fire Science, Imperial College London

Matthew Blais
Director of Fire Technology, Southwest Research Institute (SWRI)

René R. Hagen
Professor of Fire Safety, Institute for Safety (IFV)

Pär Stenmark
Chief Regulatory Affairs Officer, IKEA Range & Supply

Concluding remarks

Guillermo Rein

Professor of Fire Science, Imperial College London

Networking Lunch

Furniture Fire Safety Seminar

How to make sure that your sofa is fire safe?

FLAME RETARDANTS EUROPE

IFV Instituut Fysieke Veiligheid

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L42 Business Centre
Rue de la Loi 42, 1040 Brussels