

HAZARDS OF FIRES IN CHILDREN'S ROOMS – EXPERIMENTAL AND NUMERICAL INVESTIGATION OF DIFFERENT SCENARIOS



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Project

Our project
*Modelling Fire Scenarios in
Residential Buildings with
Respect to the Benefit of Smoke
Detectors and Flame Retardants*
is sponsored by EFRA:
European Flame Retardants
Association.



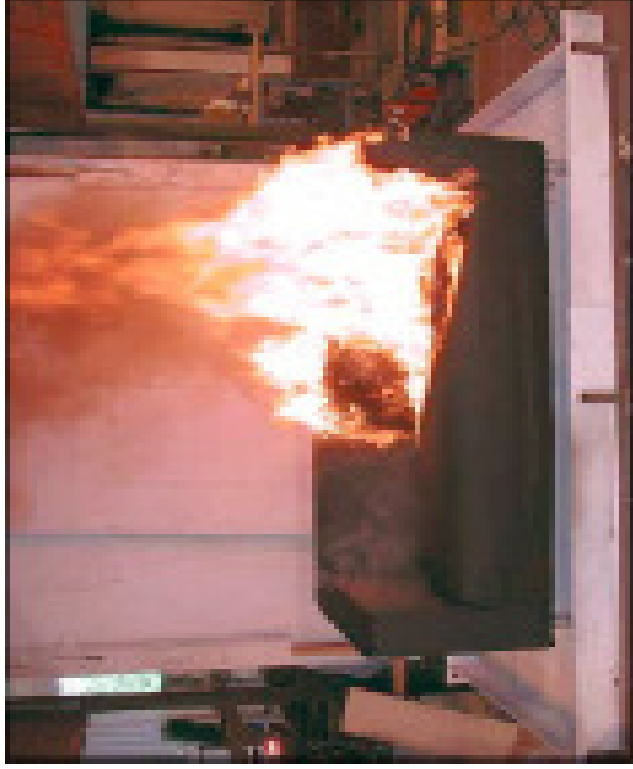
Contents

- Hazardous Home Fires – Fires in Children’s rooms
- Smoke Detectors and Flame Retardants
- Large scale tests: living room / children’s room
- Numerical investigations
 - Validation
 - Different home fire scenarios with and without flame retardant furniture, with smoke detectors
 - Results
- **Conclusions**

European Home Fires

- Hazardous home fires: 80 % of all fire fatalities in homes
- Fire spread is very fast: only 2 to 4 minutes escape time after fire detection, earlier tests in 1970s described longer escape times
- Living and bed room are very hazardous: they often lead to fatalities: 21 % of home fires but 72 % of fatalities
- Different concepts in Europe to minimise fire losses: Smoke detectors and flame retardants

High Risk Items



Copyright: SP, Sweden



Fires in Children's rooms

- Accumulation of high risk items
 - Mattresses
 - Upholstery
 - Electrical devices (TV sets, computer)
 - Toys (plastic)
- Wrong behaviour:
 - Playing with fire – one quarter of suspects to arson are under the age of 14
 - Hiding

Real cases

15 real fires in children's rooms (Germany):

- In 8 cases the cause of the fire was known:
 - Small ignition sources in all 8 cases
 - In 7 cases a high risk item was the first burning item
 - In 5 cases a child caused the fire
- In most of the cases flashover has already occurred before the fire service was on scene (app. 10 minutes after first emergency call)
- In all cases: no smoke detectors were installed / no regulations for high risk items in Germany

Smoke Detectors / Flame Retardants

- Valuable to wake and warn sleeping persons
- Escape time (2 to 4 minutes) is very short , especially for very young, older or disabled persons
- Batteries have to be changed regularly
- Flame retardants lead in general to later (or no) ignition and can lower the heat release rate of the burning item
- Only several items of furniture are equipped with flame retardants (e.g. upholstery or television sets)

CFD (Computational Fluid Dynamics)

- Field model: room is divided into cells (FVM)
- Balances of mass, momentum, energy
- Submodels: chemical reaction, radiation, soot, turbulence; and material parameters
- Furniture with and without flame retardants
- Different home geometries, closed, open and breaking windows
- Smoke detectors
- ▶ **Results: temperatures, velocities, gas concentrations in the room, smoke production and smoke movement**

Large Scale Tests



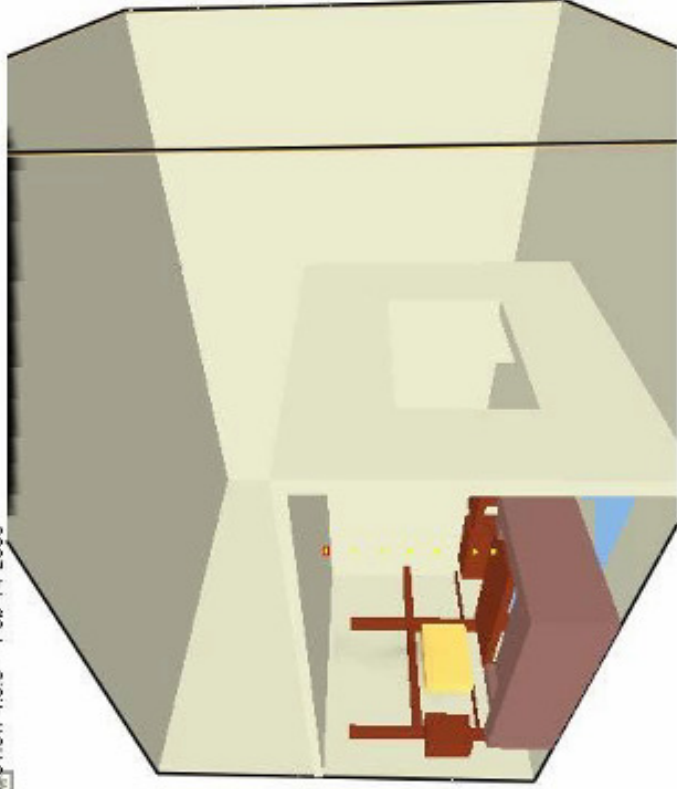
Living room



Childrens room

Fire Test: Living room

VIDEOMACHSCREENVIEW 4.0.5 - Feb 14 2005



Frame: 437

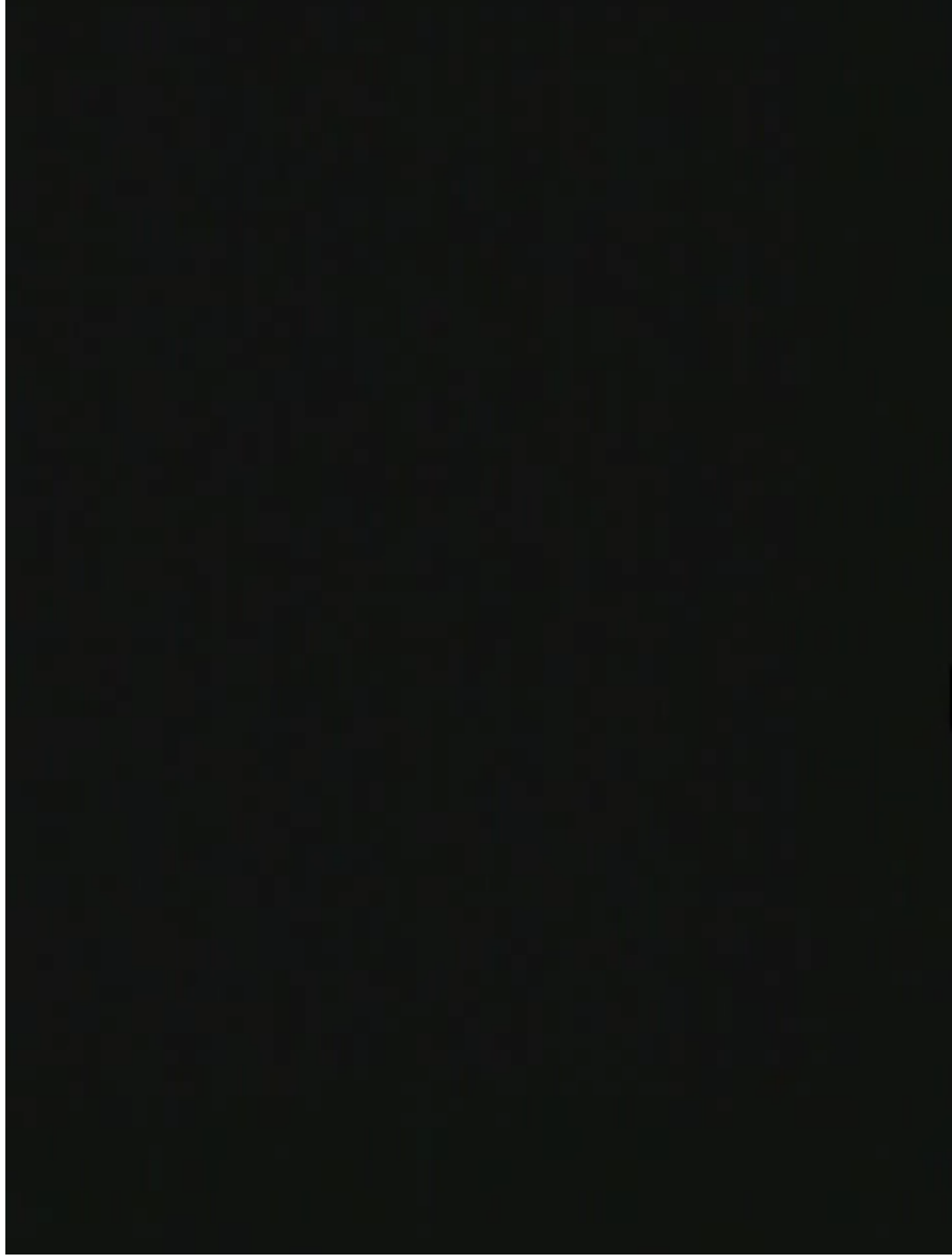
Time: 80.1



Numerical model

Test video

Fire Test: Children's room



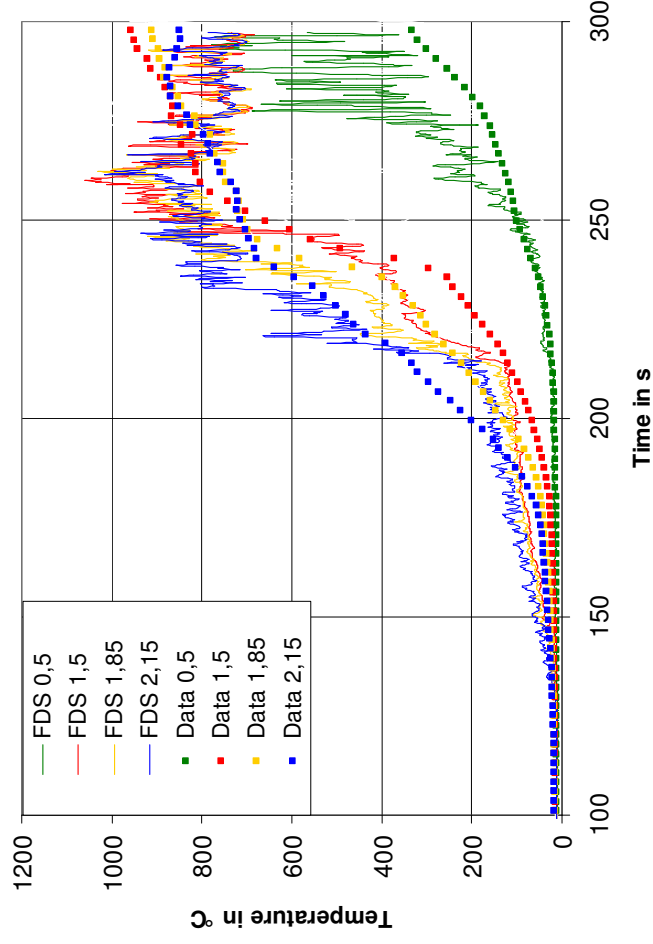
Model Geometry

VIDEOTAC 3DVIEW 4.0.5 - Feb 14 2005

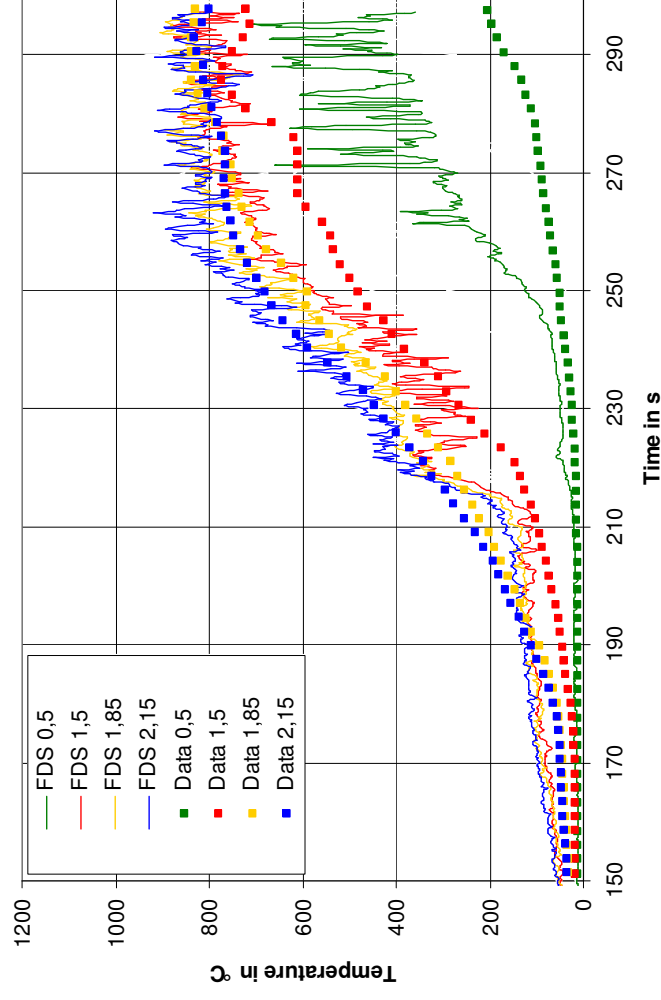


Observations	Fire test	Numerical model
Only lower mattress burns	1:30 min	2:10 min
Lower and upper mattress burn	3:00 min	3:00 min
Flashover	4:00 min	3:45 min
Flames out of window	4:30 min	4:00 min
Smoke alarms	2:00 / 2:23 min	0:37 / 1:05 min

Predicted and Measured Temperatures



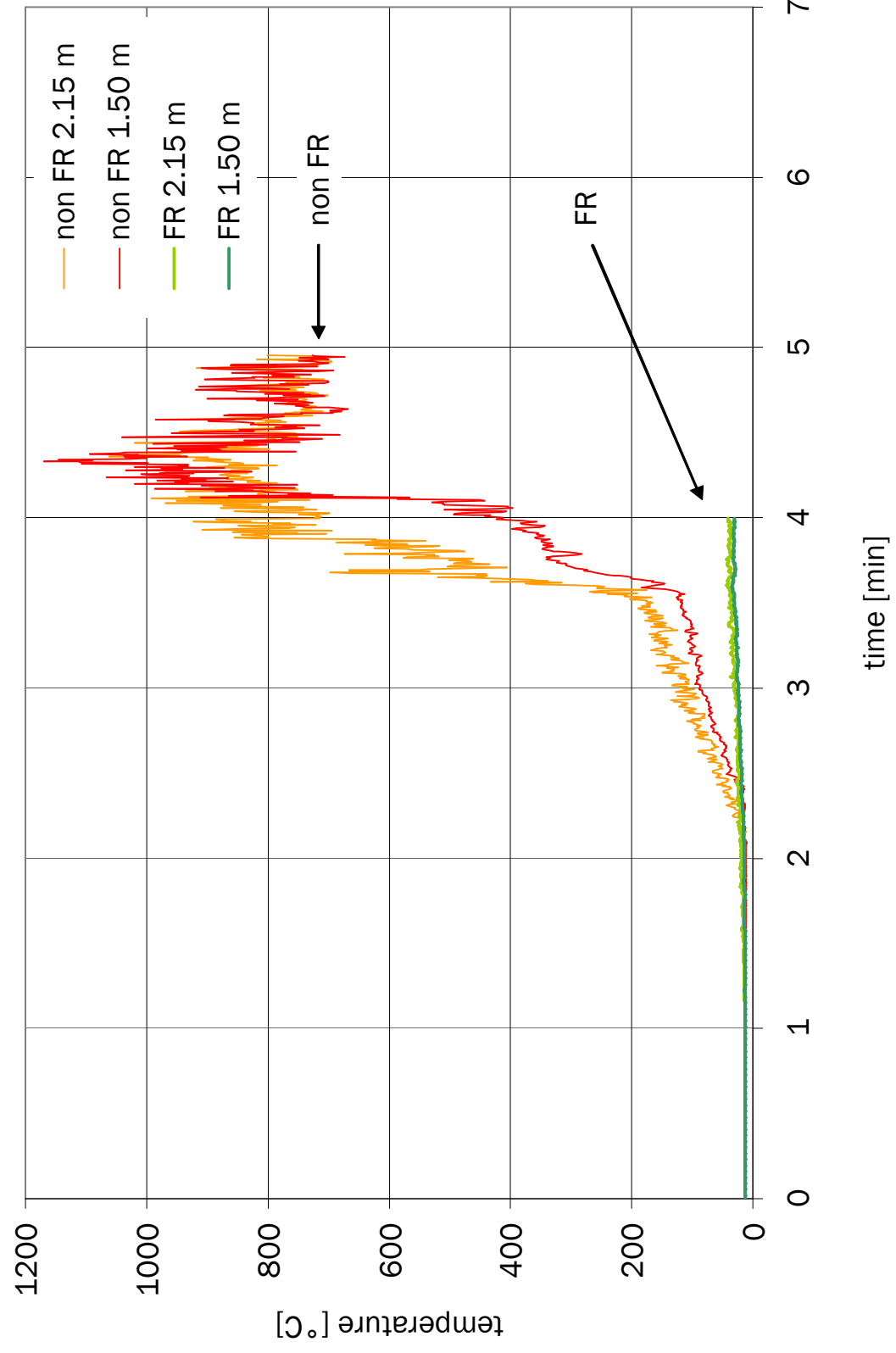
Room centre



Right front corner



Predicted Temperatures in Children's Room - Using a FR Mattress



Conclusions

- Fires in children's rooms are very hazardous:
 - Accumulation of high risk items
 - In most cases: no smoke detectors
 - Fire development: very fast
 - Wrong behaviour of children / parents
- Combination of measures: Installation of smoke detectors and use of flame retardants / appropriate materials for high risk items and education (prevention of fires and right behaviour)

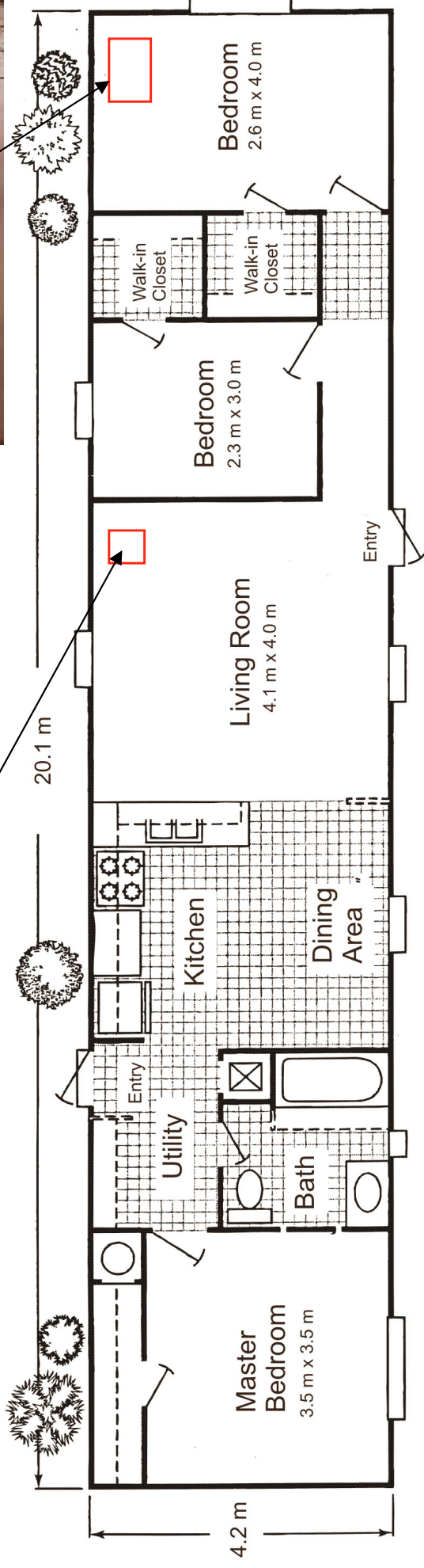
Thank you for your attention !

UK Fire Statistics

United Kingdom

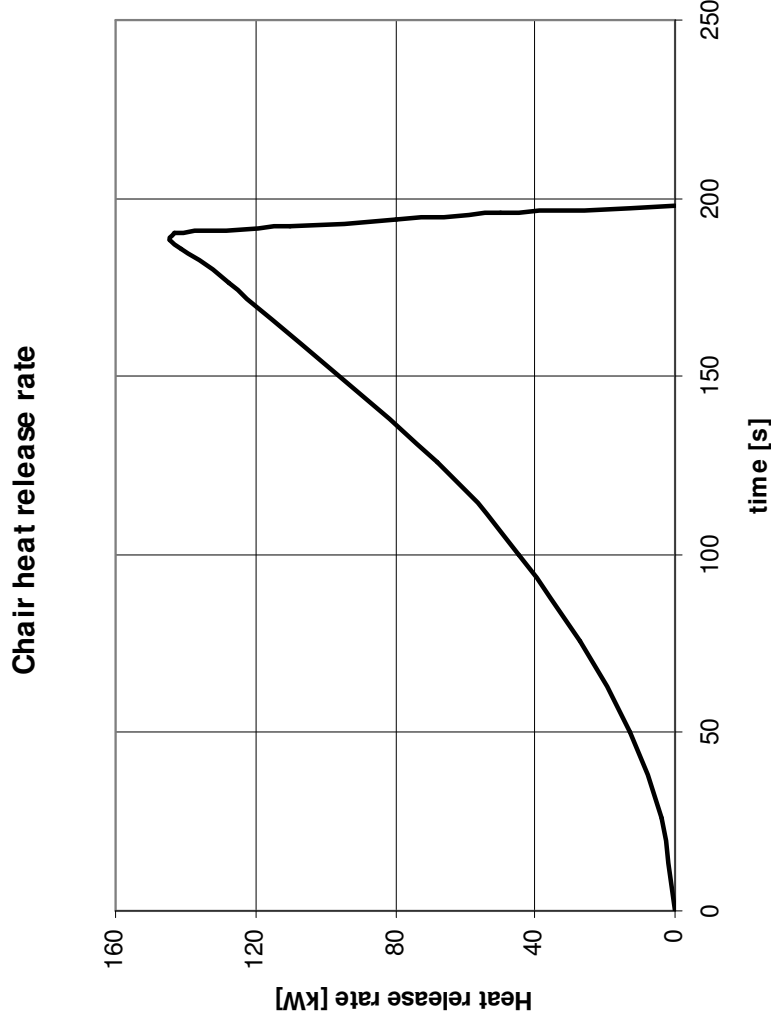
	Fires		Fatal casualties	
	2002	2001	Total Per 1000 fires	Total Per 1000 fires
Total accidental	50 828	54 266	355	428
Bedroom or bedsitting room	5 369 21 %	5 670	105 72 %	127
Living room, dining room or lounge	5 400	5 432	150	175
Kitchen	32 650 64 %	35 113	70	92
				3

Validation: Manufactured House



Validation A1: Given HRR

Heat release rate of flaming chair:



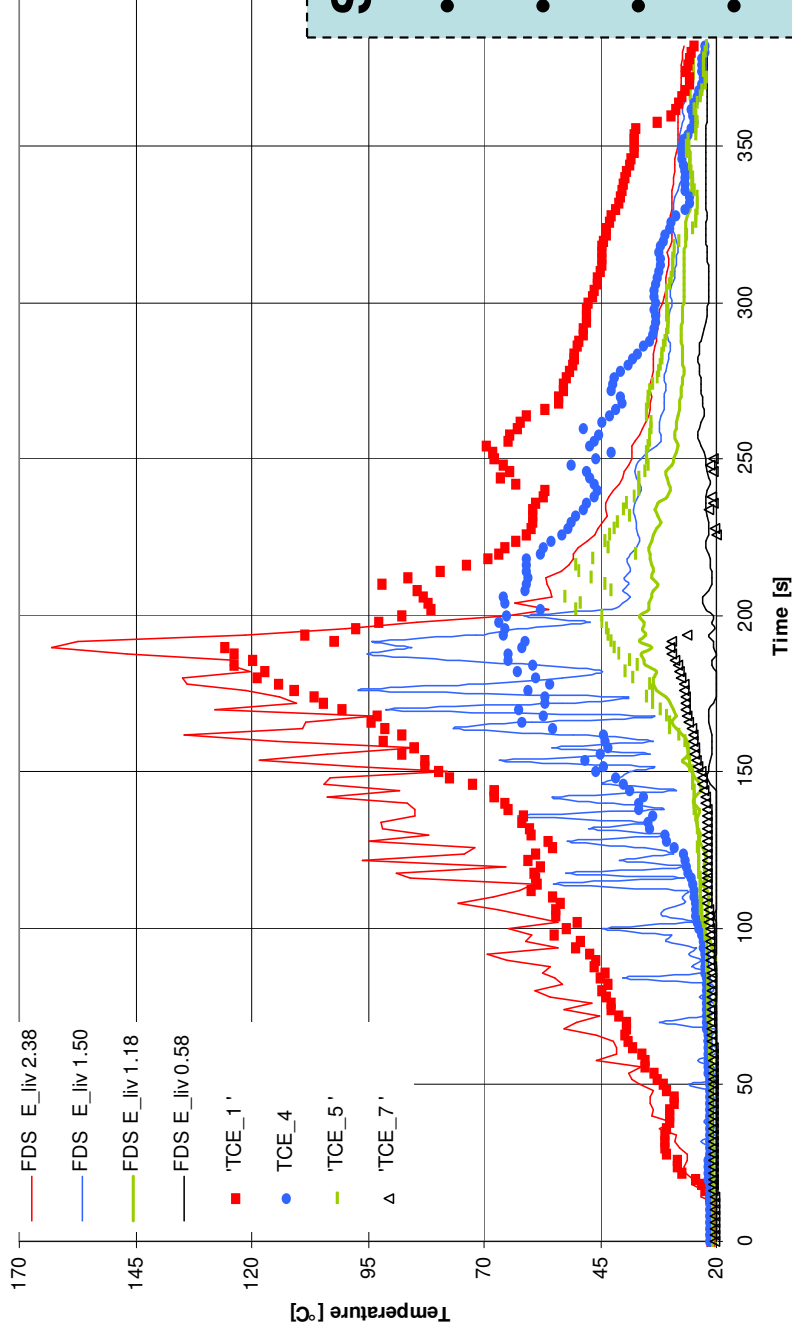
Submodels / input data:

- Chemical reaction
- Smoke production
- Radiation
- Turbulence
- Material properties for upholstery

Validation A1: Given HRR



Predicted and measured temperatures in living room



Submodels / input data:

- Chemical reaction
- Smoke production
- Radiation
- Turbulence
- Material properties for upholstery

Validation A2: Full chemical model

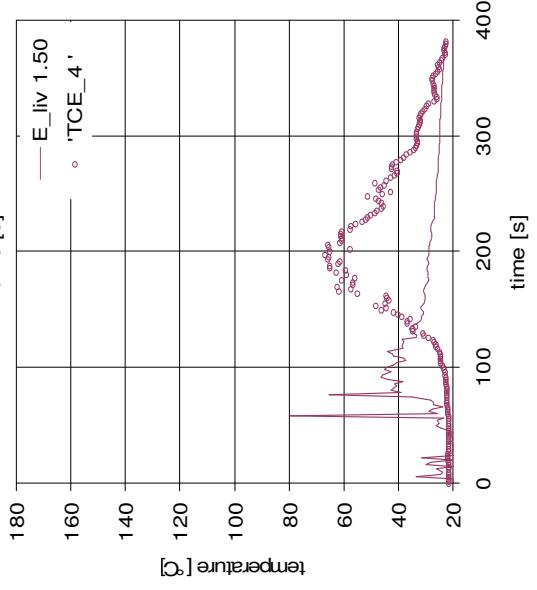
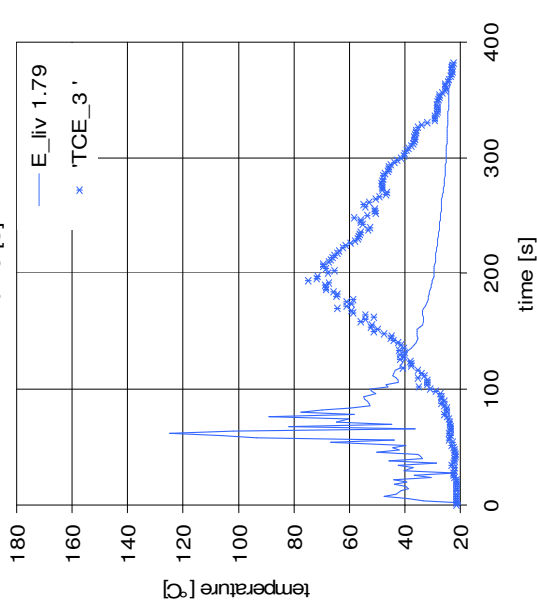
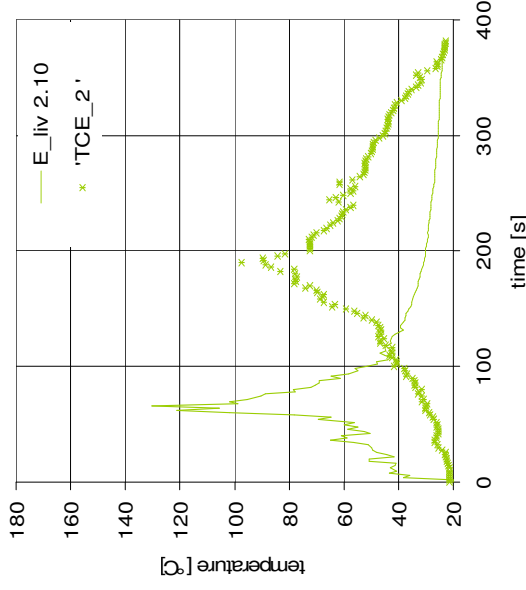
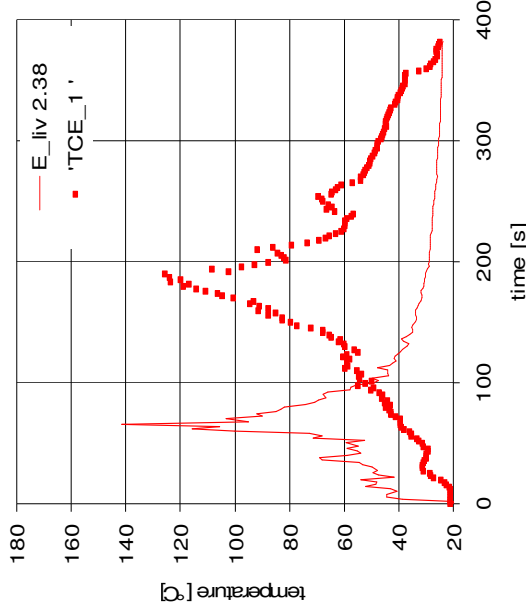
- Ignition: spark for 20 s
- Material: upholstery (NIST data)
- Reaction: polyurethane (FDS: NFPA Handbook, Babrauskas)



Submodels / input data:

- Chemical reaction
- Smoke production
- Radiation
- Turbulence
- Material properties for upholstery

Validation A2: Full chemical model



Submodels / input data:

- Chemical reaction
- Smoke production
- Radiation
- Turbulence
- Material properties for upholstery

High Risk Items

- Upholstery: a single item could cause flashover in a room
- TV: 2 to 3 min to peak of HRR, lot of smoke (faster development than refrigerator/washing machine, lower peak)
- Toys (plastic): ignition with lighter after 3 sec, burning for 15 min (only 50 g specimen)

Comparison

Observations in Fire Test		Numerical model
Only TV burns	6:20 min	6:10 min
Shelf burns	8:30 min	7:00 min
Flashover	10:30 min	7:52 min
Flames out of window	11:00 min	9:00 min
Smoke detector	4:47 min	1:30 min