# USE OF FIRE AND EVACUATION MODELS IN PRACTICE OF FIRE AND RESCUE SERVICE OF THE CZECH REPUBLIC

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# Outline

- Short introduction of Technical Institute of Fire Protection
- Short overview of system of fire investigation in the Czech republic
- Main challenges in cooperation of investigators and fire modelers
- Case study: Fire in nursing home with 8 fatalities
  - Introduction
  - Cooperation with investigators
  - Results
  - Conclusion and Consequences after the investigation

# Technical Institute of Fire protection

- The Technical Institute of Fire Protection is a part of the General Headquarters of the Fire Rescue Service (FRS) of the Czech Republic

- TIFP deals with:
  - testing of technical equipment of fire protection and certification
  - research and development
  - fire investigation in special cases

# Fire Investigation in the Czech republic

- Cooperation of the fire investigators from FRS and police.

TIFP involved when…

- fire caused significant property loss
- led to multiple fatalities
- advanced examination of chemical or electrical appliances samples is needed

Fire model can be requested

- hypothesis about type or amount of the ignition source (material) or location of the fire origin
- to show difference between actual fire and the fire if all the fire code requirements would be fulfilled

# Typical questions of fire investigators

- “What was the possible threat to passengers in case of the explosive device successful initiation?.”

- **What temperature** can be reached by burning one piece of luggage in baggage compartment?
- **Is this temperature sufficient to** ignite more pieces of luggage in engine compartment?
- Is this temperature sufficient to ignite bus installation?
- **Would smoke spread** to the passenger compartment?
- In which phase would fire be probably noticed by anybody in the bus?

# Case Study – Deadly fire in a nursing home

- Building from the year 1985
- Converted from the home for elderly people to home for people with mental illnesses without any special changes…
- 34 clients accommodated in total
- One member of staff during night
- Fire started in early morning between 4 and 5 am.
- It started in the common room - same fire section as five client rooms (17 clients)
- No fire detection
- 8 fatalities and 5 clients seriously injured - one of the most severe fire in last 30 years

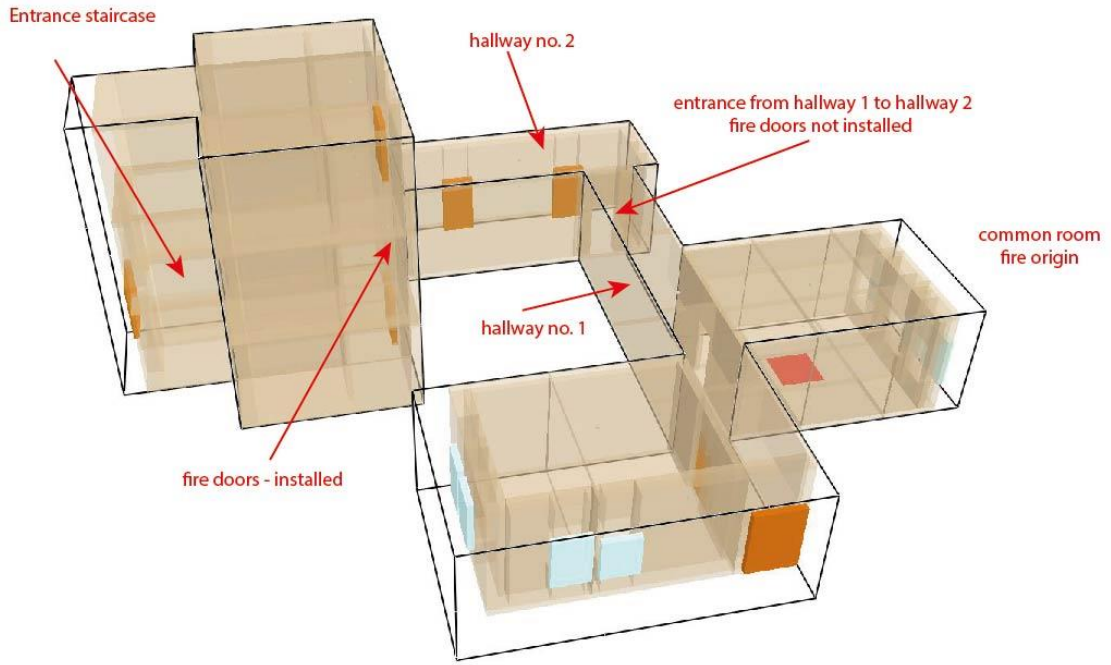
# Case Study – Results of investigation

- The fire was set by one of the clients, who set small pillow on fire
- Direct offender of the fire was found not responsible because of his mental health
- Fire could propagate for almost 30 minutes unnoticed – no fire detection
- Investigation of possible violation of the building codes is still ongoing

# Case Study – versions

## Real fire

- Started in common room
- Fire doors between hall 1 and 2 not installed
- Fire doors to staircase open

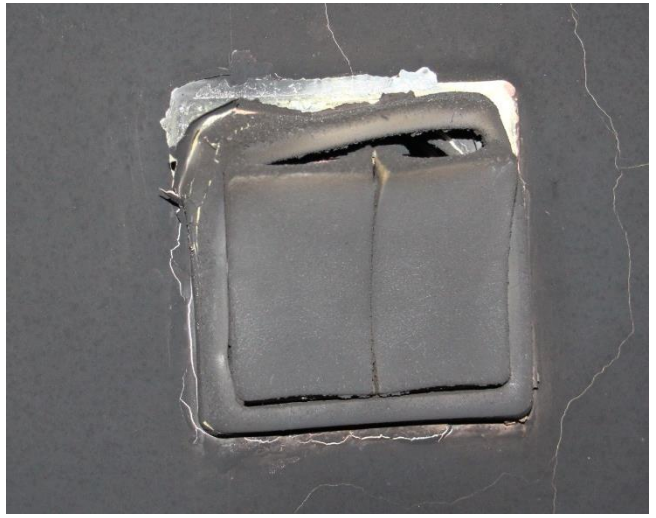



## „Ideal“ fire

- Started in common room
- Fire doors between hall 1 and 2 installed
- Fire doors to staircase closed

# Case Study – Cooperation with investigators:

- Authors of the fire model directly on the fire scene few days after the fire
- All the details of the building construction and fire itself could have been studied from the point of view of the model input parameters and traces.
- Best traces, which were then used in calibrating the model was height of the smoke layer determined by soot deposits on the walls and temperature profile, which was determined by various items…



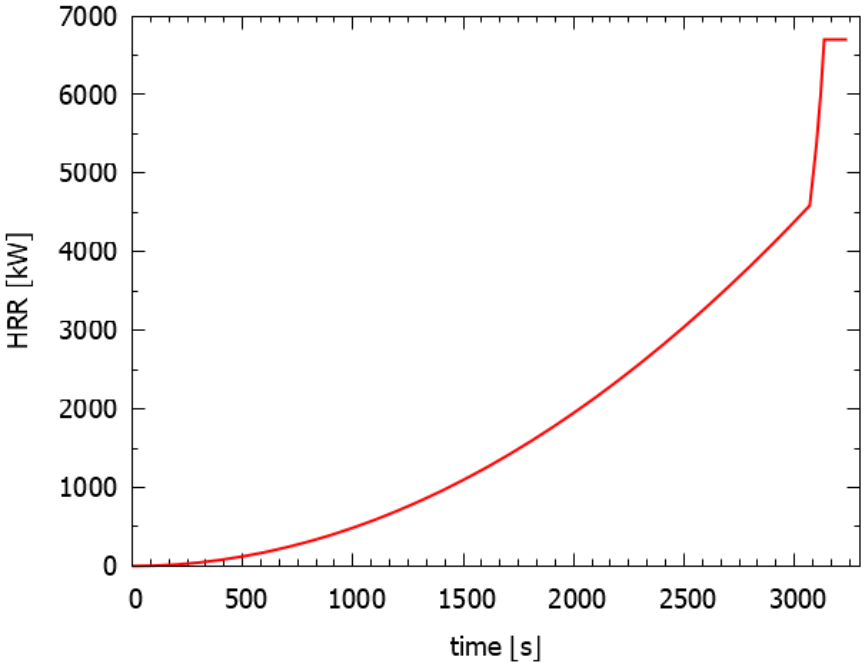
# Case Study – Fire source

Assumed that the fire was ventilation limited.

- Fire occurred during the winter
- Building was equipped with modern well sealed windows

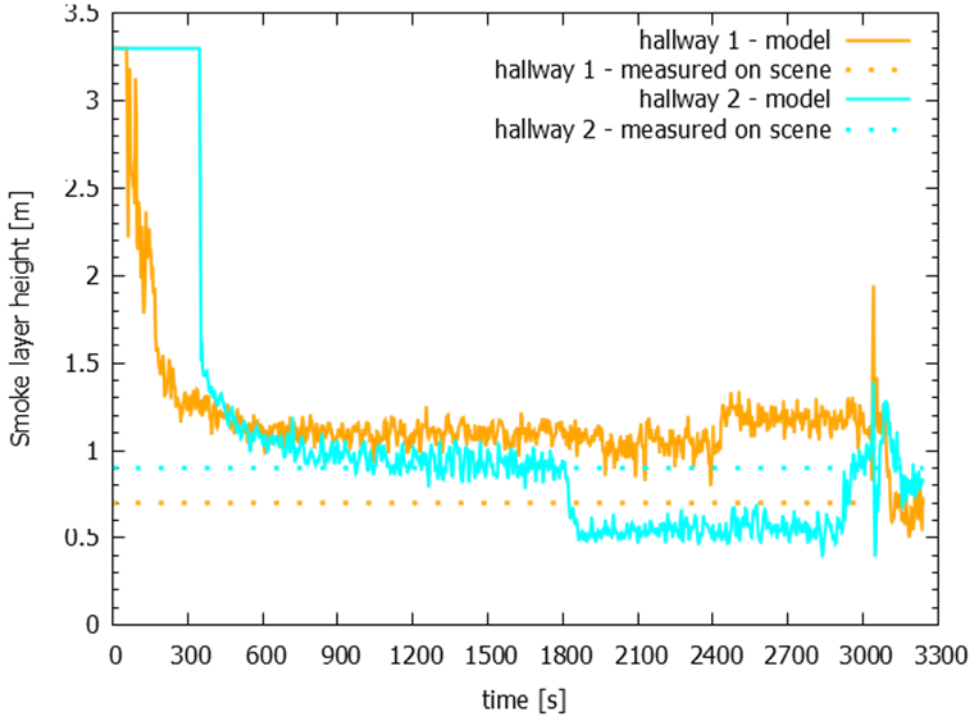
Maximum heat release rate was derived from oxygen available from three windows

- $HRR_{max} = 1500\ A_0\sqrt{H_0}$, = 6,7 MW
- Time of breakage was obtained = maximum HRR (found from video footage)
- *HRR* from assumed beginning of the fire to the maximum assumed HRR was approximated as a t-squared fire.

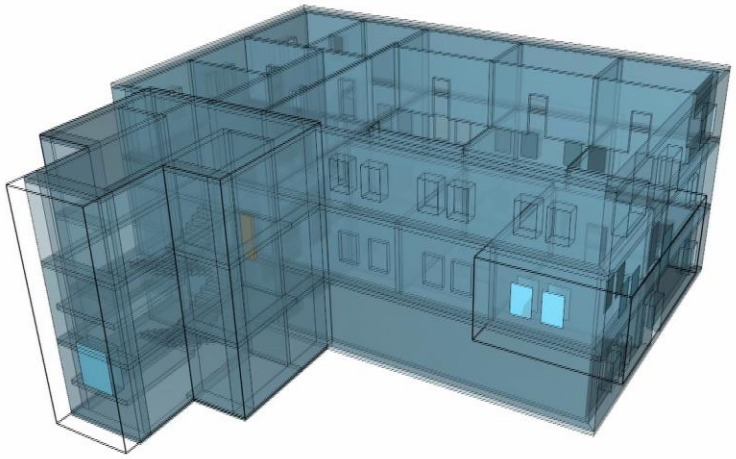


# Case Study – RESULTS - Smoke layer height

- Smoke layer height at the fire scene determined from soot deposits on the wall.
- Hallway one - 0,9 meter
- Hallway two - 0,7 meter.
- FDS model showed values 1,1 and 0,9 meters
- Considered as a good enough approximation.



# Case Study – RESULTS – Smoke spread



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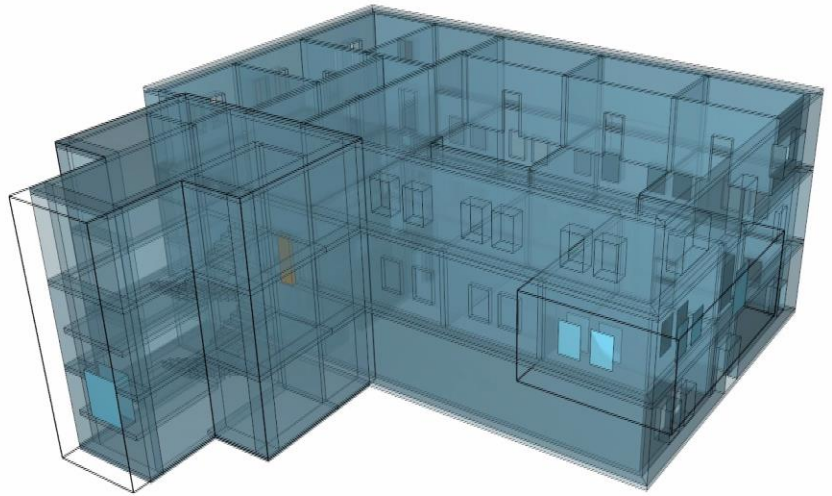
Real fire – no fire compartments



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Hypothetic fire –
fire compartments
in acordance with
design

# Case Study – RESULTS – Smoke detector activation

| Time to detection | | Common room | Hallway 1 | Hallway 2 |
|---|---|---|---|---|
| **Used model** | | FDS | FDS | FDS |
| **Real fire** | (sec) | 16 | 83 | 217 |
| | (min:sec) | 0:16 | 1:23 | 3:37 |
| **Ideal case** | (sec) | 16 | 88 | Not activated |
| | (min:sec) | 0:16 | 1:28 | |
| | (min:sec) | 00:41 | 01:29 | |

- Default settings of smoke detectors
- Time to detection in order of seconds or minutes
- Significantly less then 30 minutes

# Case Study – Consequences after investigation

- Building were the fire occurred was reconstructed.
- Internal layout of the building was changed so the common rooms are the separate fire sections.
- Equipped with smoke detection system

- Discussion how to prevent such fires in the future.
- Change of fire code in Czech republic
- All buildings of this kind have to be equipped with:
  - fire detection system (if more than 50 clients are present)
  - autonomous smoke detectors (If less then 50 clients are present).
  - change applied retrospectively (3 years) to prevent such fire in a future.