

Available Safe Egress Time (ASET)

meaning and example of calculation

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Agenda

- Some general words on performance based design
- Design criteria for ASET calculations
- Example ASET calculation



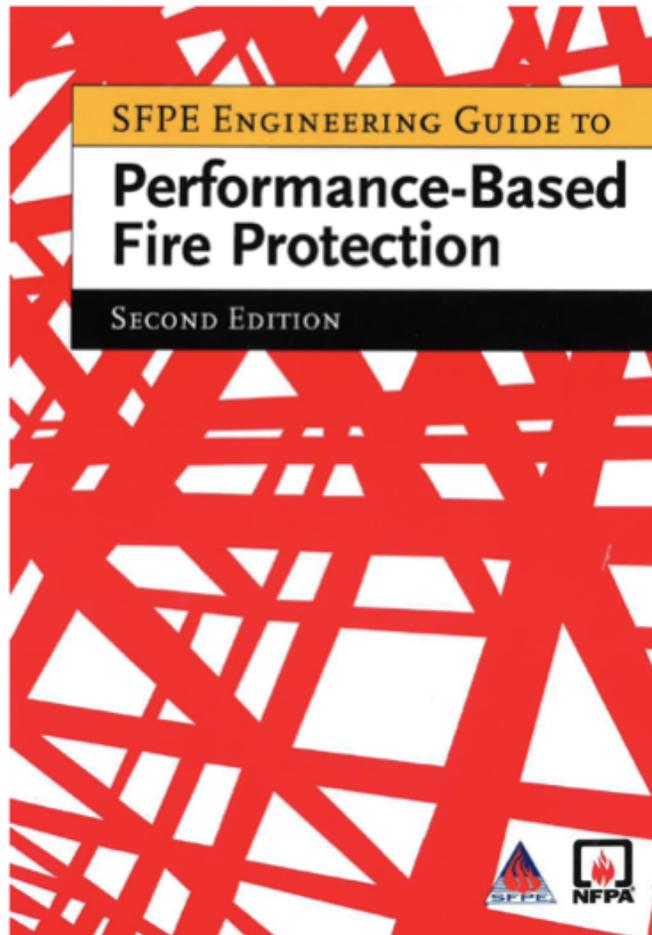
Fire safety evaluation

The fire protection engineer can use different approaches for evaluating the performance of the fire safety design

Two different approaches exist in many codes:

- Prescriptive design
 - deemed-to-satisfy (follow the recommendations to the codes in detail)
- Performance-based design
 - qualitative or quantitative analyses (show that the requirements in the codes are fulfilled)
- Codes can be prescriptive, fully performance based or hybrid

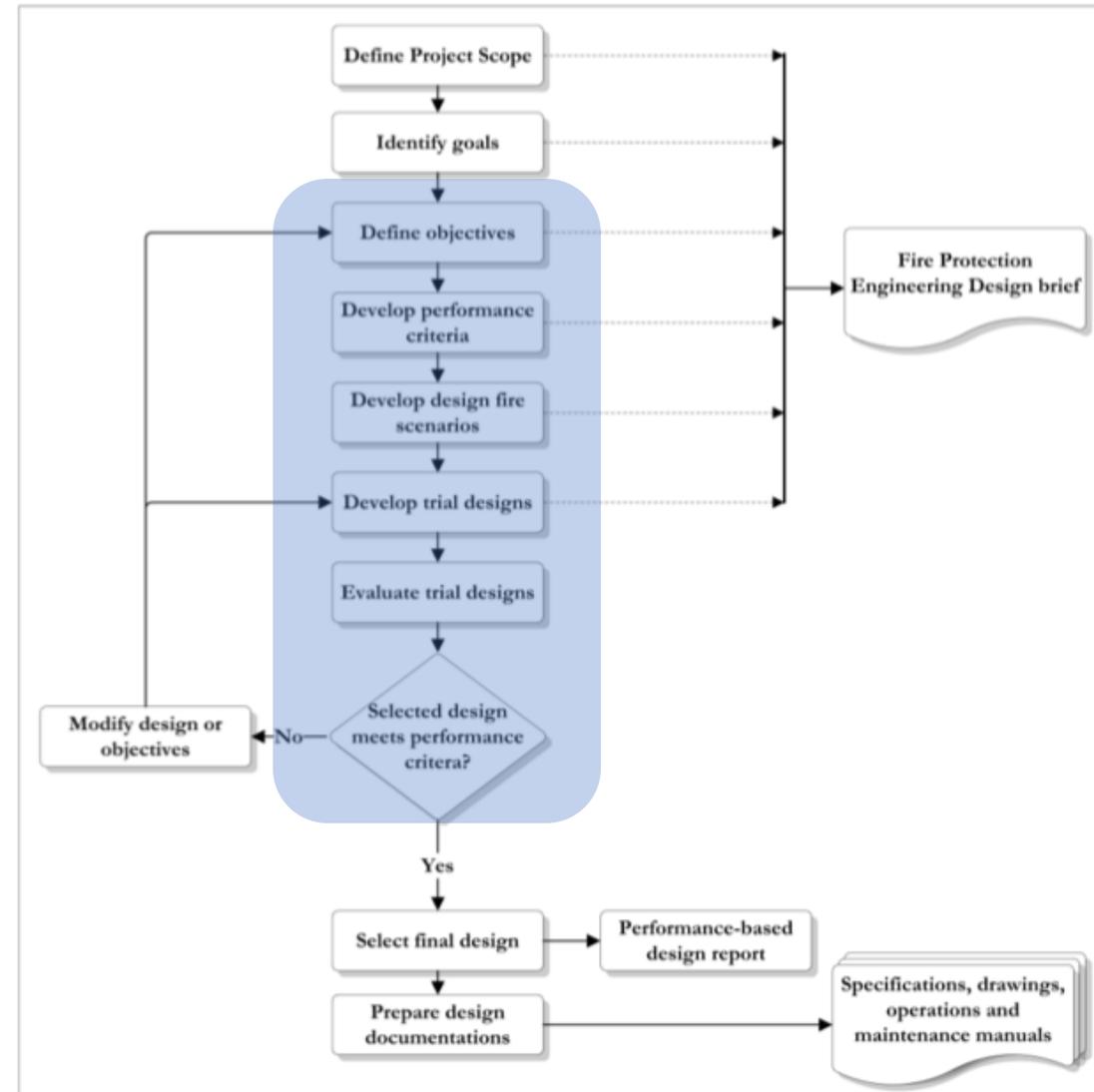
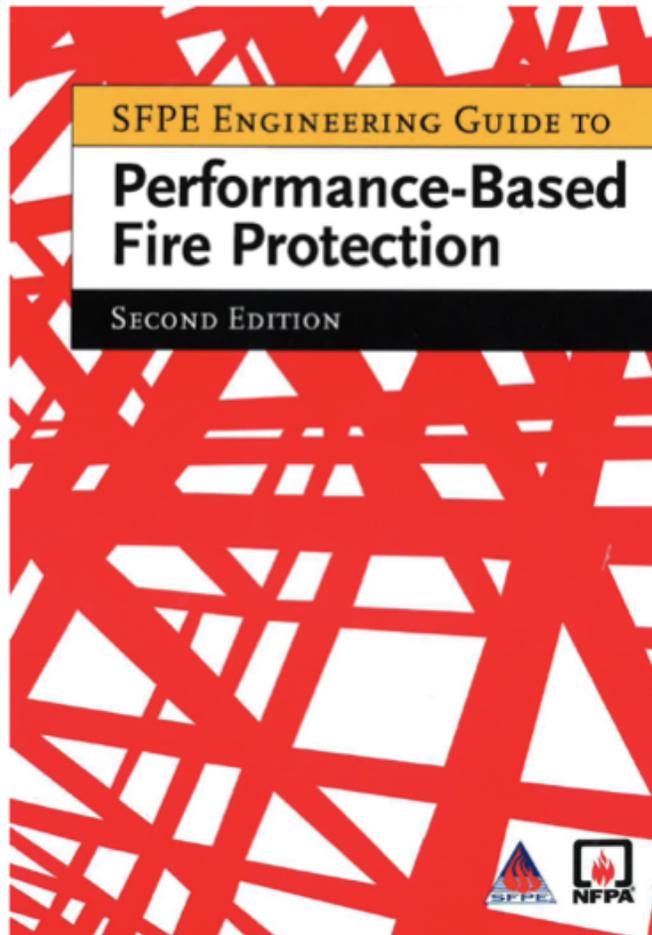
Performance-based design



“An engineering approach to fire protection design based on:

- (1) Agreed on fire safety goals and objectives
- (2) Deterministic and/or probabilistic analysis of fire scenarios
- (3) Quantitative assessment of design alternatives against the fire safety goals and objectives using engineering tools, methodologies, and performance criteria.

Performance-based design



Performance-based design

Main objectives to be met:

- Life safety of occupants
- Structural stability of the building
- Safety of rescue service personnel
- Property issues (fire spread within building or to other buildings)

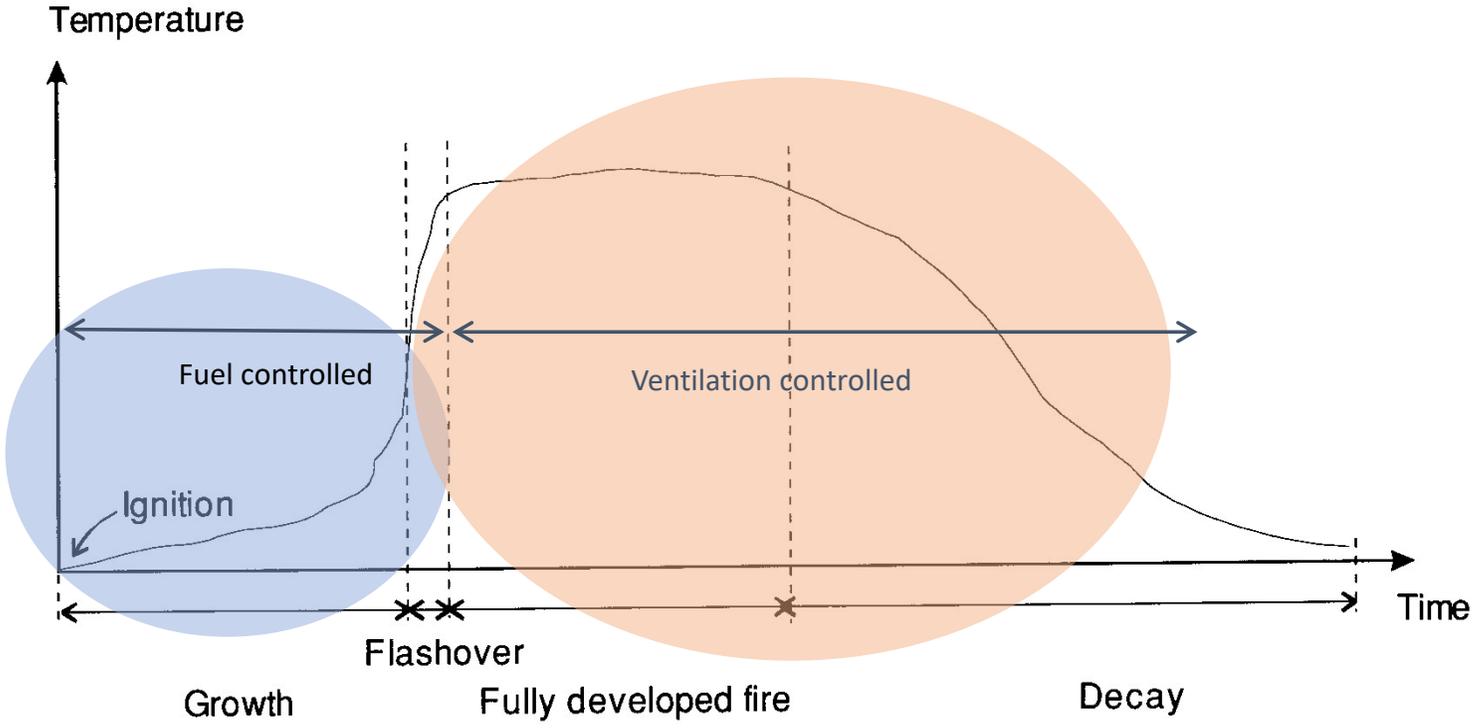
Performance-based design

Main objectives to be met:

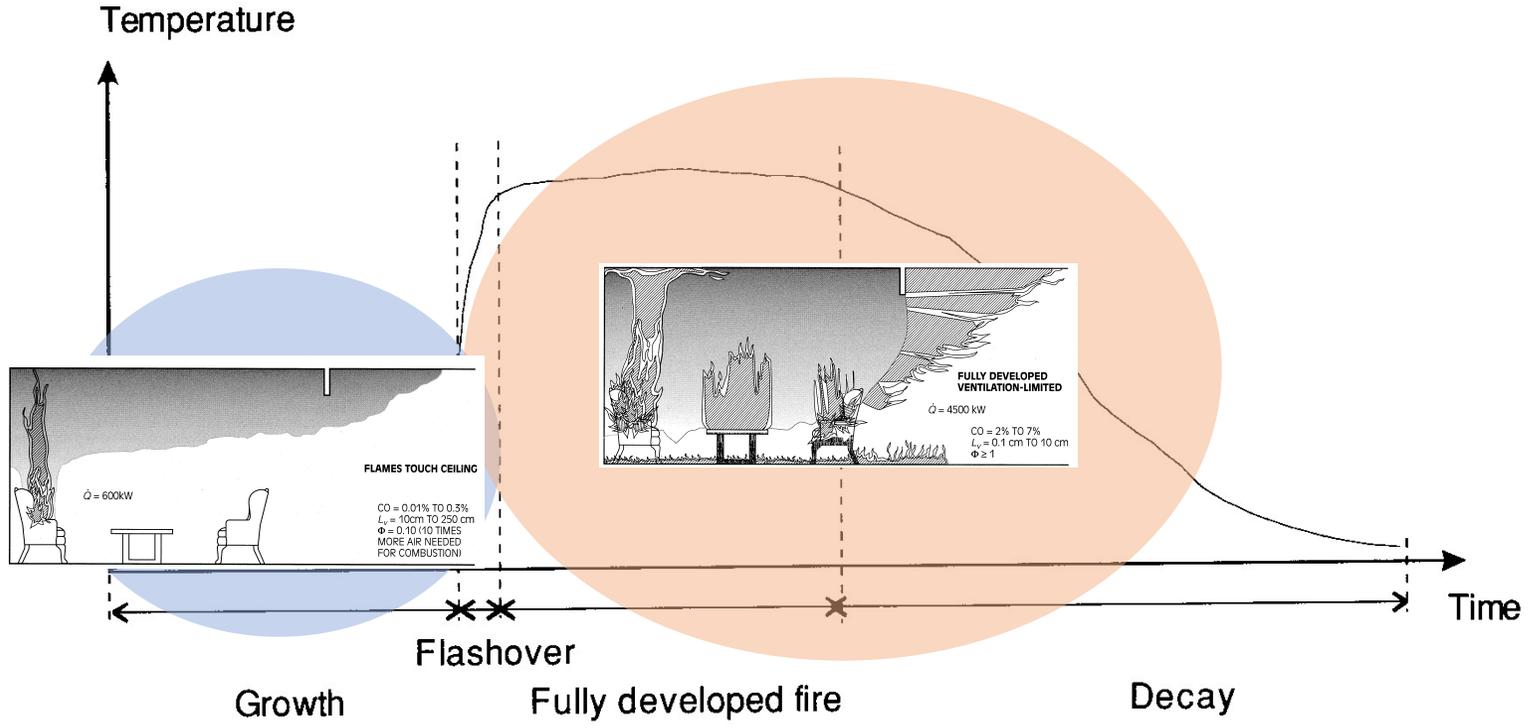
- **Life safety of occupants**
- **Structural stability of the building**
- Safety of rescue service personnel
- Property issues (fire spread within building or to other buildings)

Distinctly different fire safety design procedures apply

Temperature history in an enclosure fire



Temperature history in an enclosure fire



Performance-based design

Life safety of occupants (pre-flashover)

Required Safe
Escape Time
(RSET)



The time it takes to evacuate to a safe place

Available Safe
Escape Time
(ASET)



The time to critical conditions

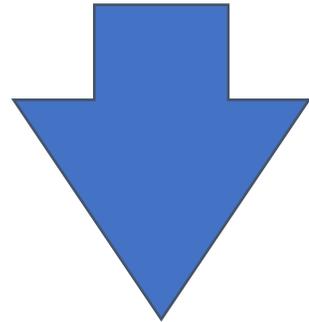
Performance-based design

Life safety of occupants (pre-flashover)

Required Safe
Escape Time
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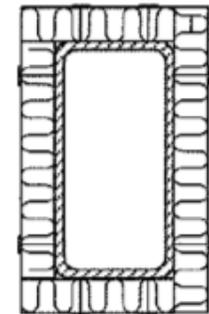
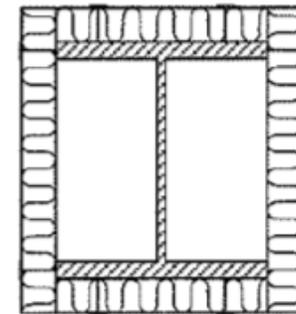
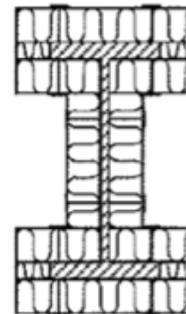
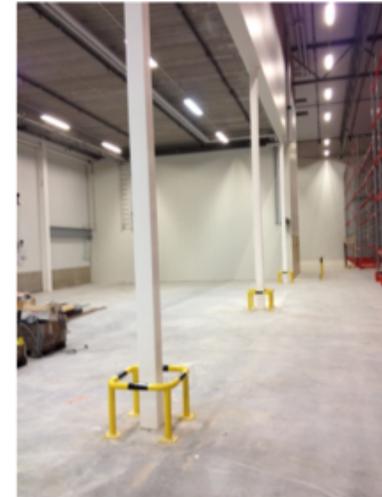
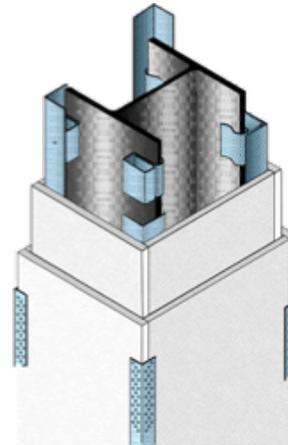
Available Safe
Escape Time
(ASET)



SAFE

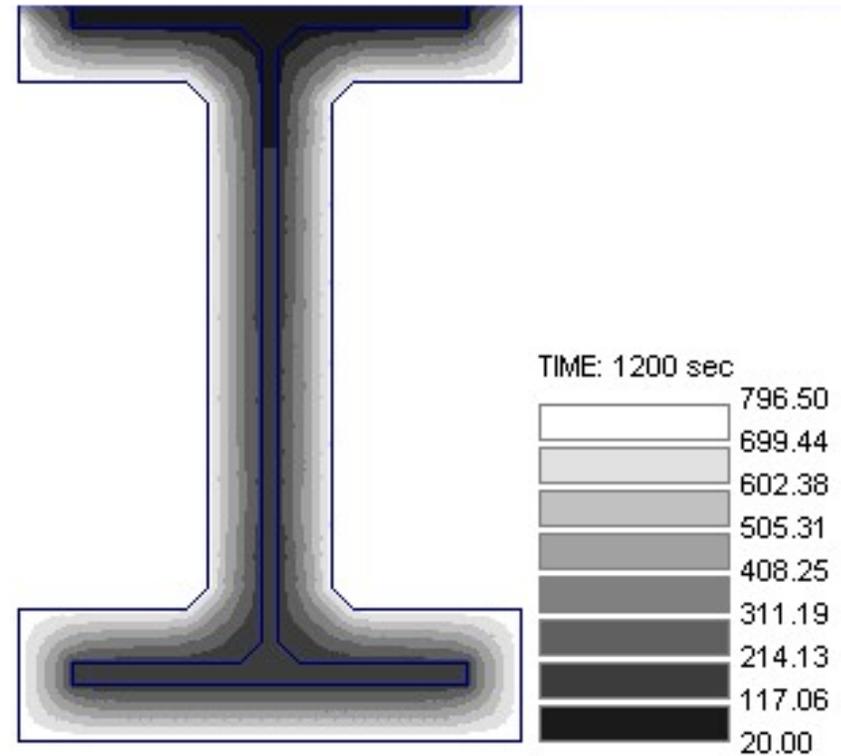
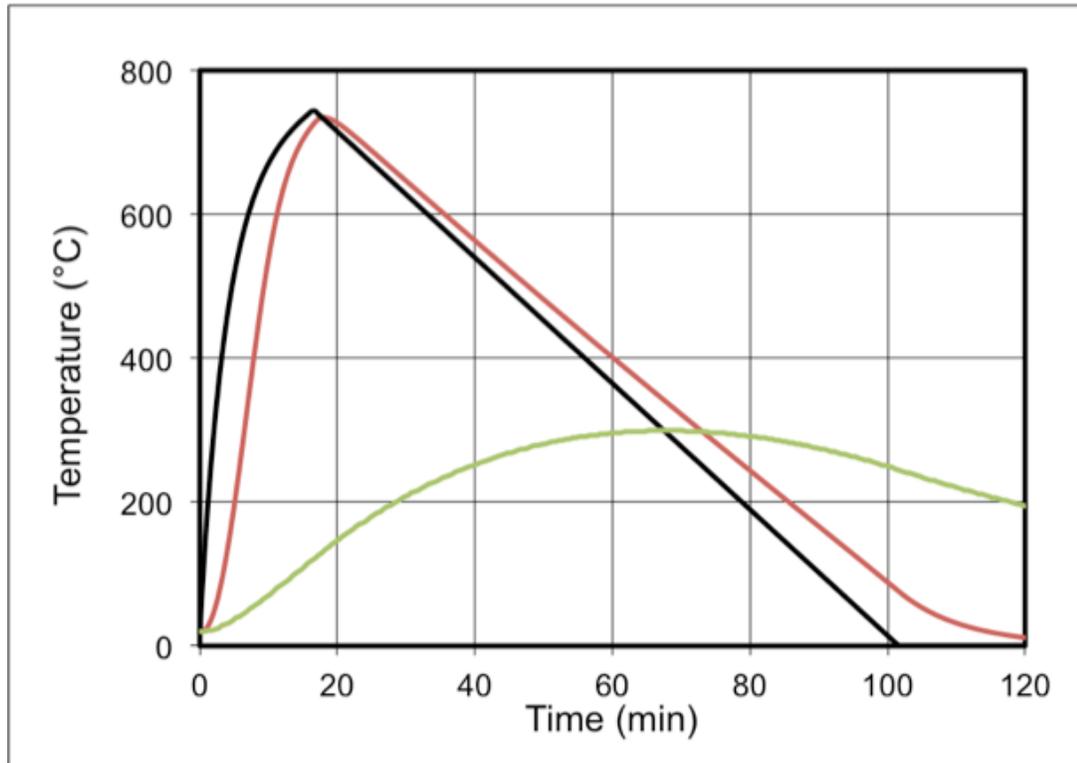
Performance-based design

Structural stability (post-flashover)



Performance-based design

Structural stability (post-flashover)



Performance criteria for ASET/RSET calcs

- These types of performance criteria are typically included in performance based building codes.
- If not, they need to be selected very carefully

Typically include:

- Thermal effects on humans
 - For example a threshold value for thermal radiation
- Toxicity
 - Inhalation exposure to product of combustion
- Visibility
 - Affects the ability to safety evacuate to a safe place

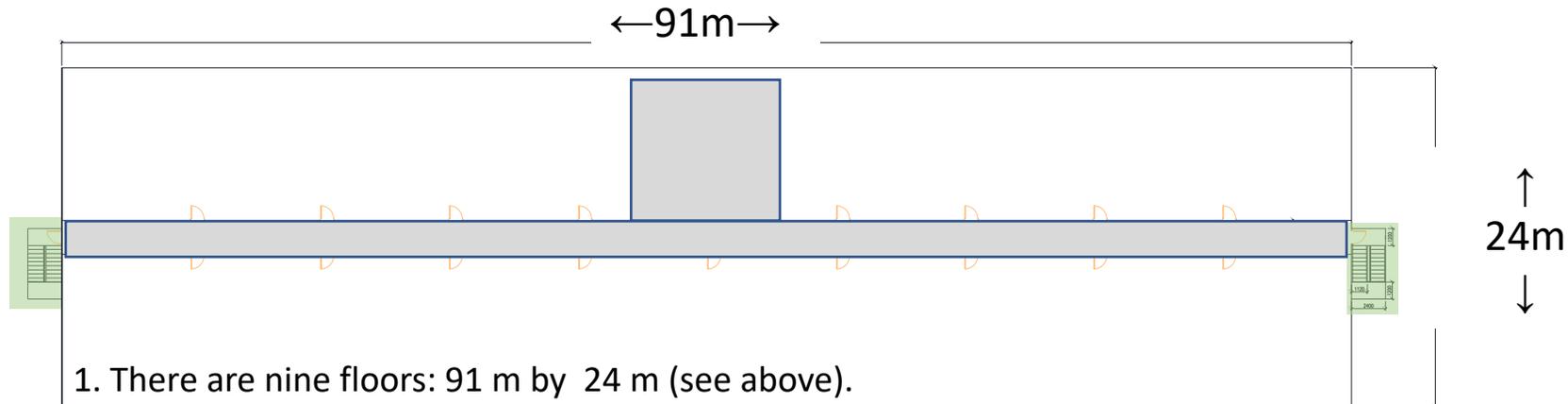
Performance criteria for ASET/RSET calcs

Performance criteria in the Swedish building code

Criteria	Level
Smoke layer height	1.6 + 10% of room height
Visibility (2 m above floor)	10 m (room area > 100 m ²) 5 m (room area < 100 m ²)
Heat flux	2.5 kW/m ²
Temperature	max 80°C
Toxicity (2 m above floor)	CO < 2 000 ppm CO ₂ < 5 % O ₂ > 15 %

Design fire scenario, example

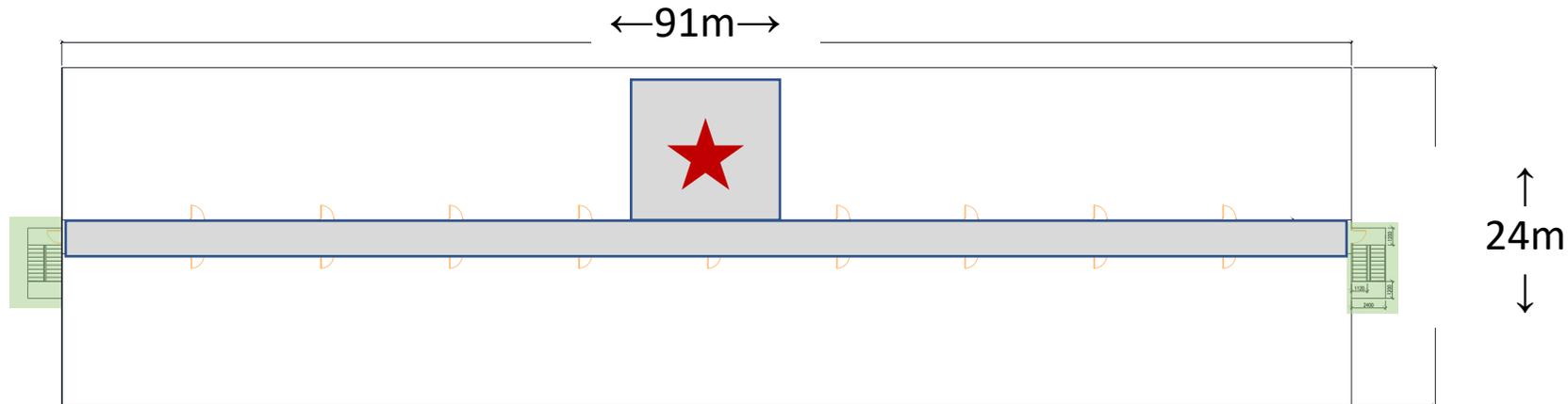
Fictive building, office building or similar



1. There are nine floors: 91 m by 24 m (see above).
2. Floor-to-floor height is 3.7 m.
3. Two stairways are located at the ends of the building.
4. Each stair is 1.12 m wide (tread width) with handrails protruding 0.063 m.
5. Stair risers are 0.178 m wide and treads are 0.279 m high.
6. There are two 1.2 m by 2.4 m landings per floor of stairway travel.
7. There is one 0.91m clear width door at each stairway entrance and exit.
8. The first floor population does not exit through stairways.
9. Each floor has a single 2.4m wide corridor extending the full length of each floor.

Design fire scenario, example

Fictive building, office building or similar



- Long walking distance (> 45 m) to stair
 - Problem to fulfil prescriptive requirement
- Need for performance based analysis
 - Show that people can evacuate safely

Design fire scenario

Fire scenario:

- Fire starts in Sofa
- No suppression system
- Door to corridor open
- Smoke detector in room and corridor
- Fire curve?
- Deterministic analysis
 - Worst credible case
 - However, several scenarios should be analyzed



Design fire scenario



- Deterministic analysis
 - Worst credible case
 - However, several scenarios should be analyzed



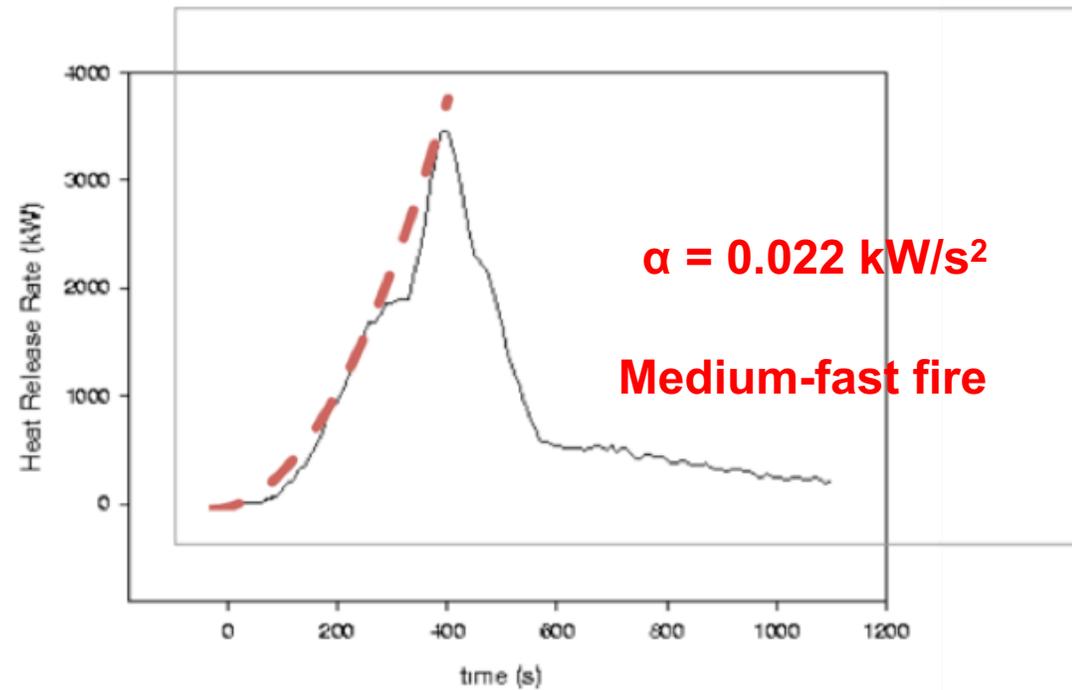
Design fire scenario



- Deterministic analysis
 - Worst credible case
 - However, several scenarios should be analyzed



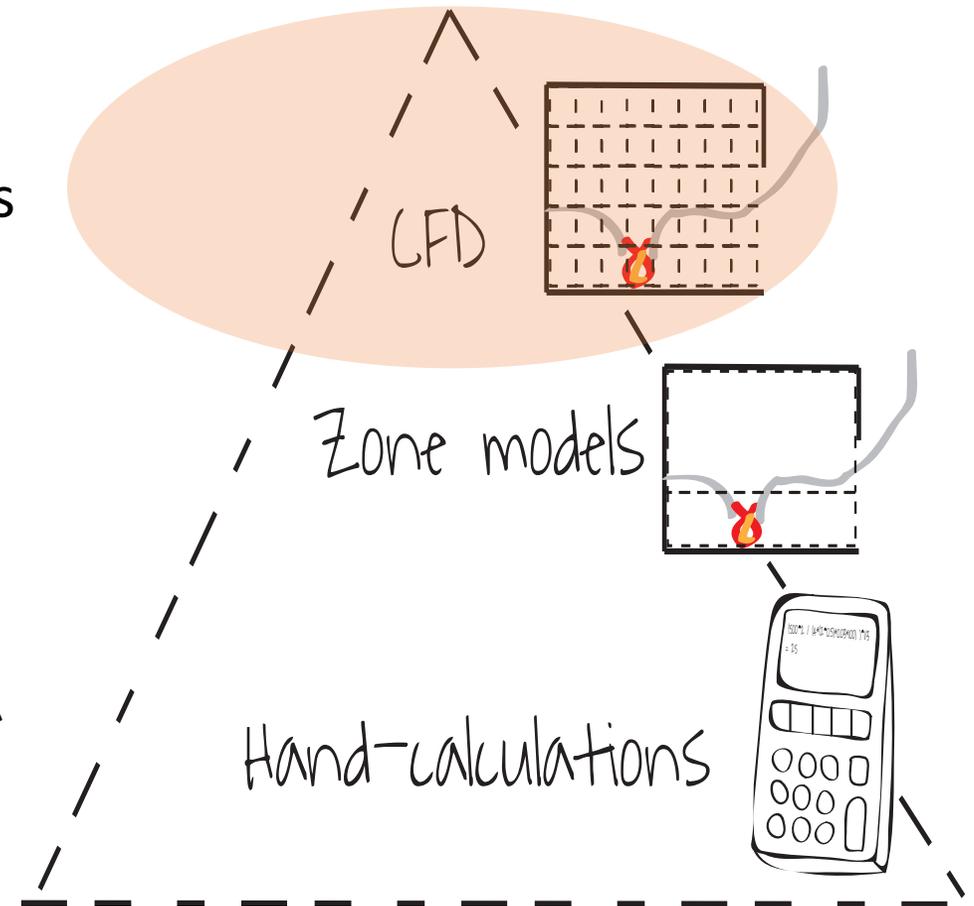
Design fire scenario



Source: <http://fire.nist.gov/fire/fires/>

Selecting method for fire modelling

- Room of origin
 - Zone model or even hand-calculations could be adequate, because rather homogenous conditions can be expected (remember when we baked cake)
- Corridor
 - Long and narrow, can homogenous conditions be expected? **NO**



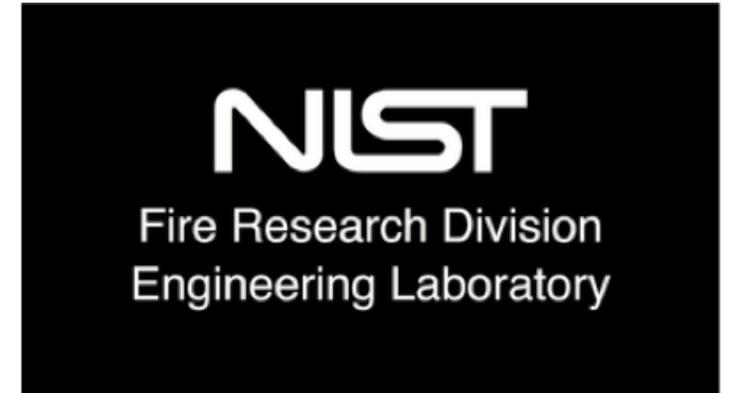
Setting up the scenario in CFD

Using the Fire Dynamics Simulator (FDS)

- CFD model developed by NIST, US

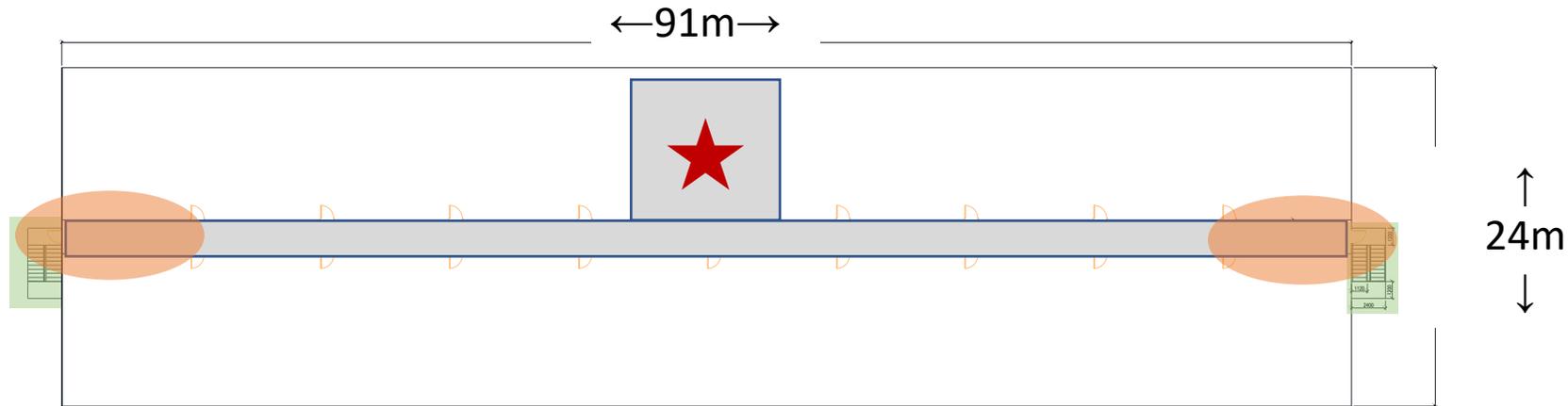
Setting up input file

- Fire with a growth rate of 0.022 kW/s^2 and peak HRR of 3.5 MW
- Soot yield 0.1 g/g
- Simulated time 600 s
- Total time for simulation about 10 hours
 - Depending on computer capacity



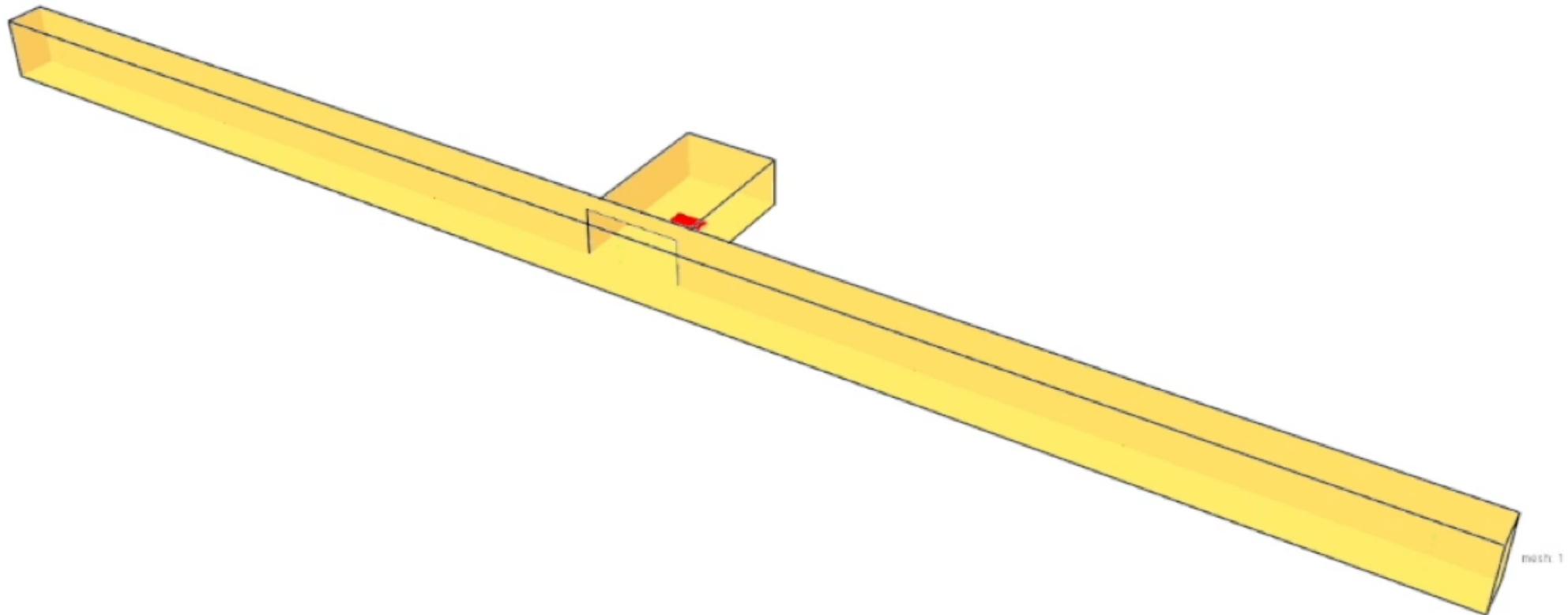
Setting up the scenario in CFD

Fictive building, office building or similar

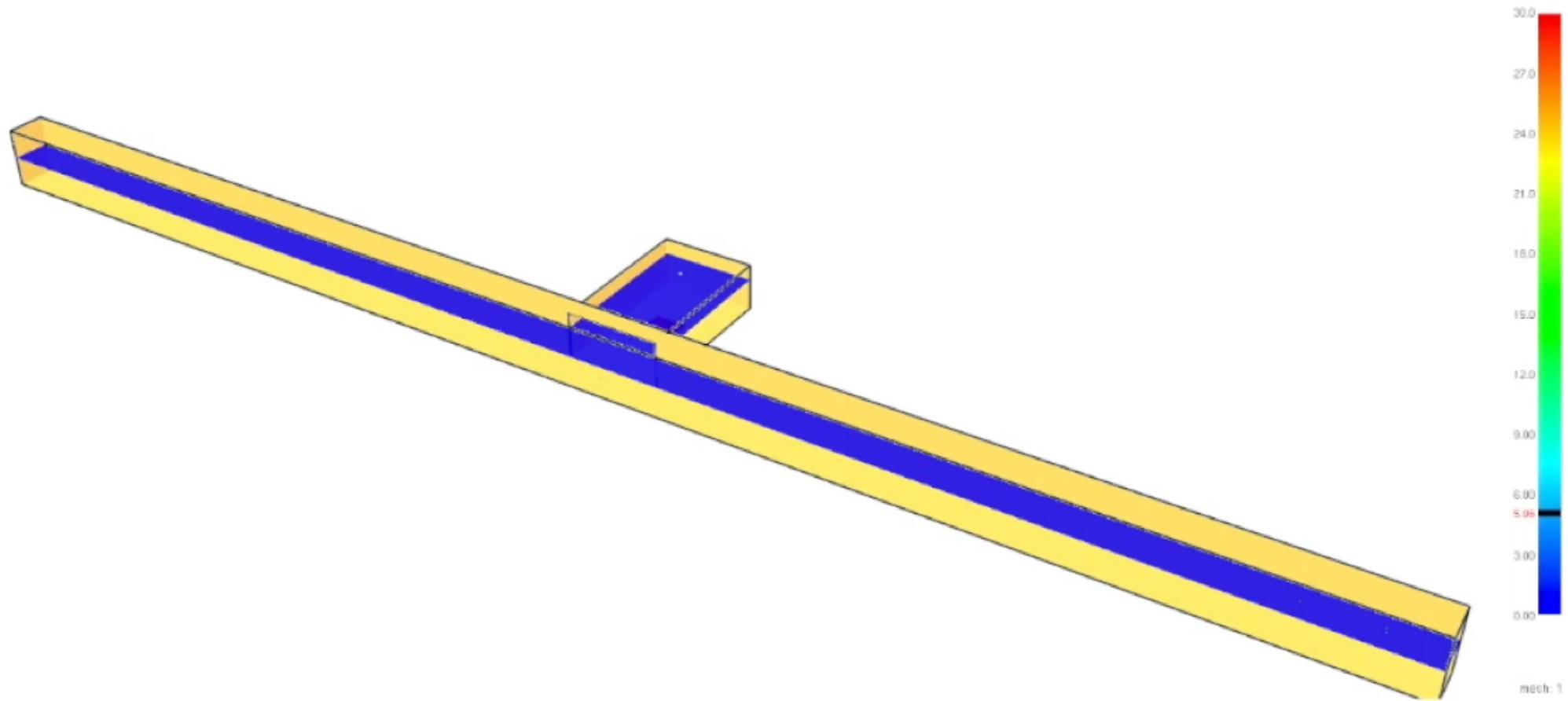


- Want to evaluate if critical conditions occur where we can expect people to be exposed
 - Cueing at stairs

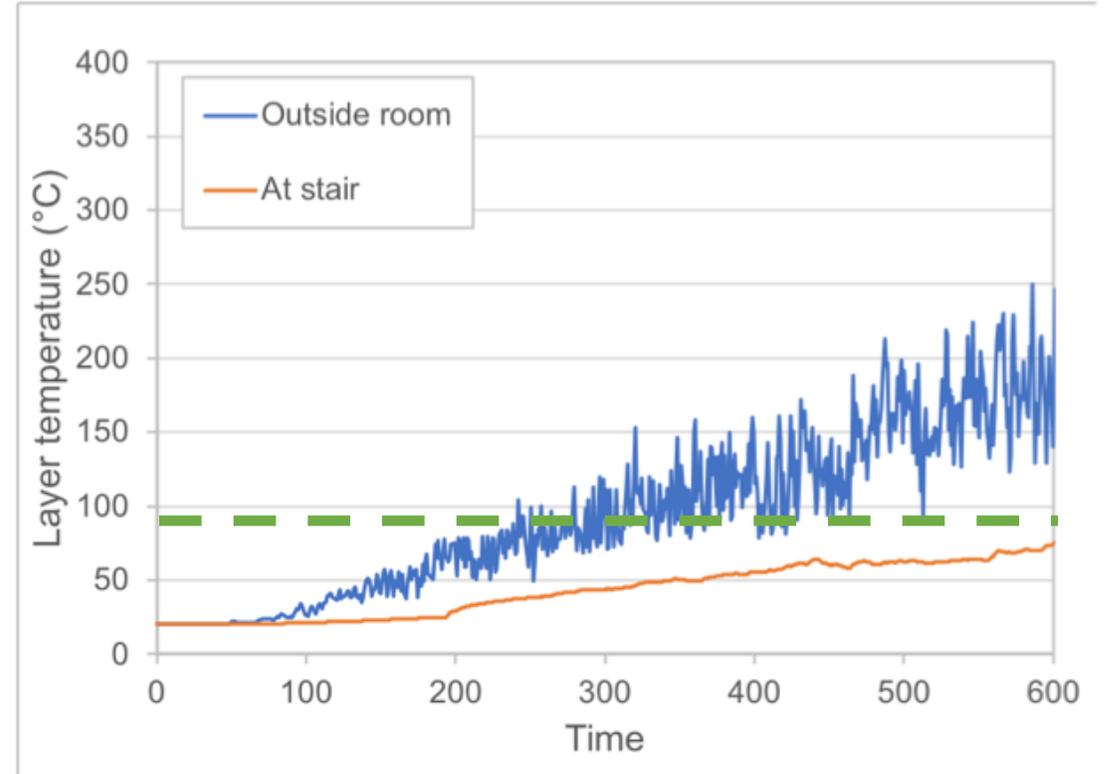
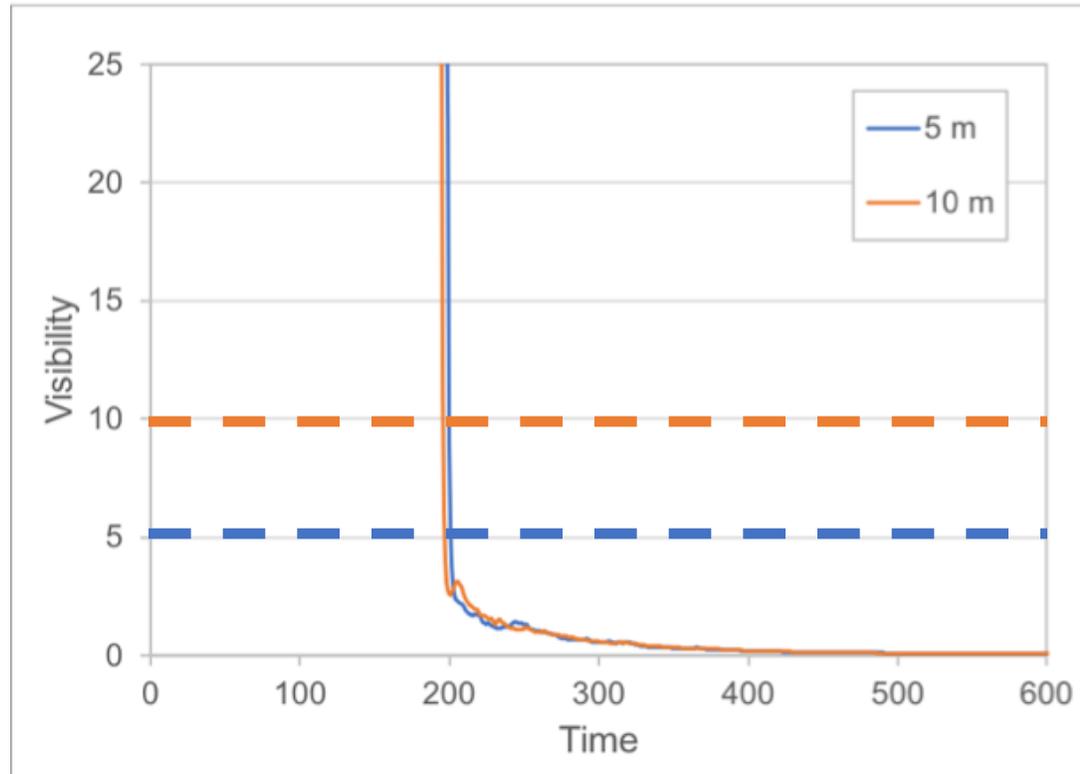
Results - temperature



Results - Visibility

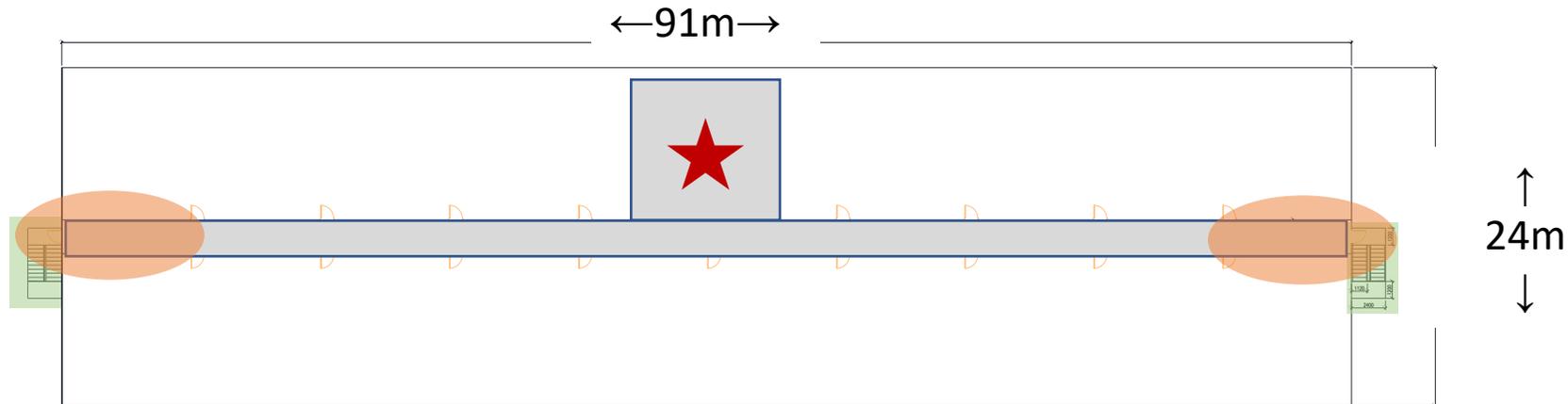


Results



Conclusion

Fictive building, office building or similar



Available Safe Egress Time

- Temperature:
 - 80°C > 600 s
- Visibility:
 - 5 m, 201 s
 - 10 m, 196 s

Evacuation needs to be finished by this time

Questions ?

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Now it is time for RSET

