•Knowledge FOr Resilient soCiEty

Fire Safety Engineering

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Fire Safety Engineering

- Why use fire safety engineering ?
- What is fire safety engineering ?
- How to use fire safety engineering
- Methods for fire safety engineering
- Life safety – critical conditions

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Why fire Safety Engineering ?

- Complex buildings
  - Atria, warehouses, shopping malls, underground car parks, tunnels, etc.
- The contents of buildings have changed
  - From heavy furniture made of wood to light furniture made of synthetic materials
- The construction industry demands optimisation of fire protection
- Performance based building codes
- Increased knowledge concerning fire

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Fire Safety Engineering

- Fire Safety Engineering can be divided into
  - Fire safety engineering concerning life safety
  - Fire safety engineering concerning preservation of property
  - Fire safety engineering concerning environmental conservation

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Fire Safety Engineering – Life safety

- Passive fire precautions
- Active fire precautions
- Fire simulations
- Evacuation simulations

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Passive fire precautions

- Do not need to be activated by fire
- Load bearing structures
  - Walls, beams, horizontal separations
- Separating structures
  - Walls
  - Glass
  - Doors
- Floors
- Roofs

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Active fire precautions

- Need to be activated by fire
  - Automatic Fire Alarm (AFA)
  - Automatic sprinkler system
  - Total flooding system
  - Evacuation signal
  - Automatic fire ventilation (AFV)
  - Automatic fire door closing systems

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Fire Safety Engineering - methods

- Fire simulations
  - Evaluating smoke and fire spread
  - Evaluating structures
  - Evaluating activation of active fire precautions
  - Evaluating life safety
- Evacuation simulation
  - Evaluating means of egress
  - Evaluating the impact of fire on humans

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Life Safety – Critical conditions

- Visibility
  - < 10 m i larger areas
  - < 5 m i smaller areas
- Smoke layer height < 1.6 m + 10 % of the height of the room
- Temperature in lower zone > 80 °C
- Heat radiation at floor > 2.5 kW/m^2
- Oxygen (O_2) concentration < 15 %
- Carbon dioxide (CO_2) concentration > 5 %
- Carbon monoxide (CO) concentration > 2000 ppm

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Performance based design

- RSET
  - Required Safe Egress Time (evacuation)
- ASET
  - Available Safe Egress Time (fire)

RSET < ASET

Sometimes also including a safety factor

RSET * safety_factor < ASET (safety factor: 1.1-1.3)

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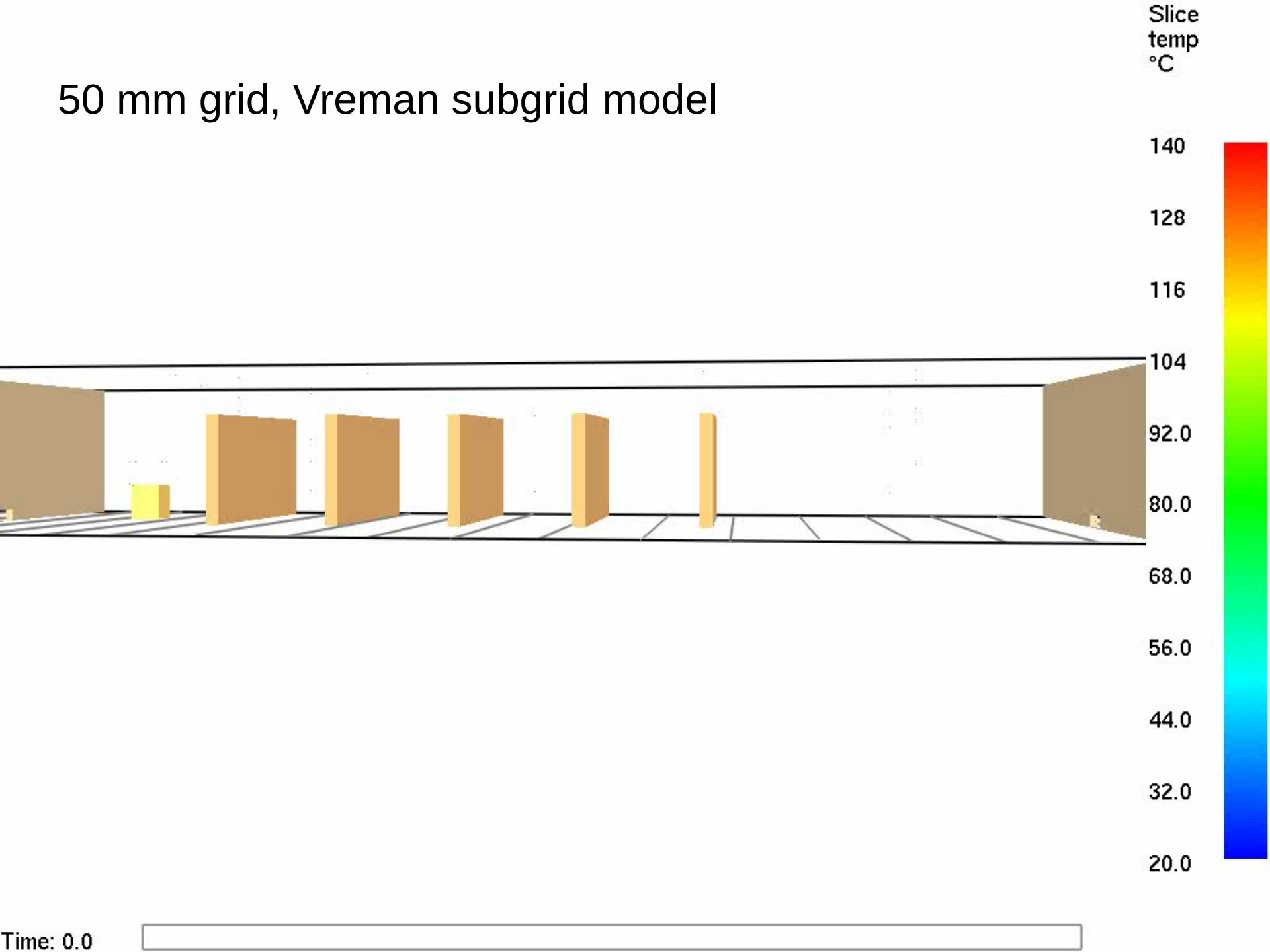
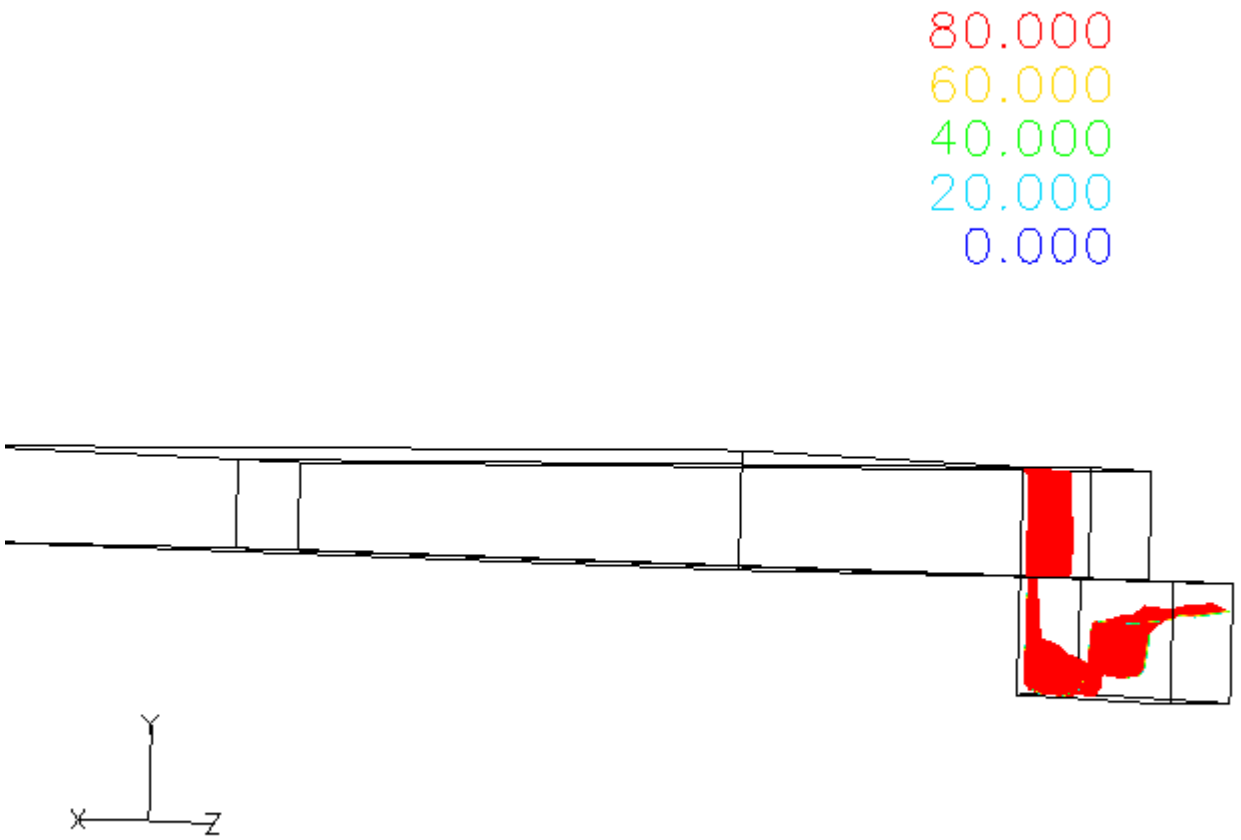
50 mm grid, Vreman subgrid model



Example from real fire in Göteborg 29. October 1998 63 fatalities



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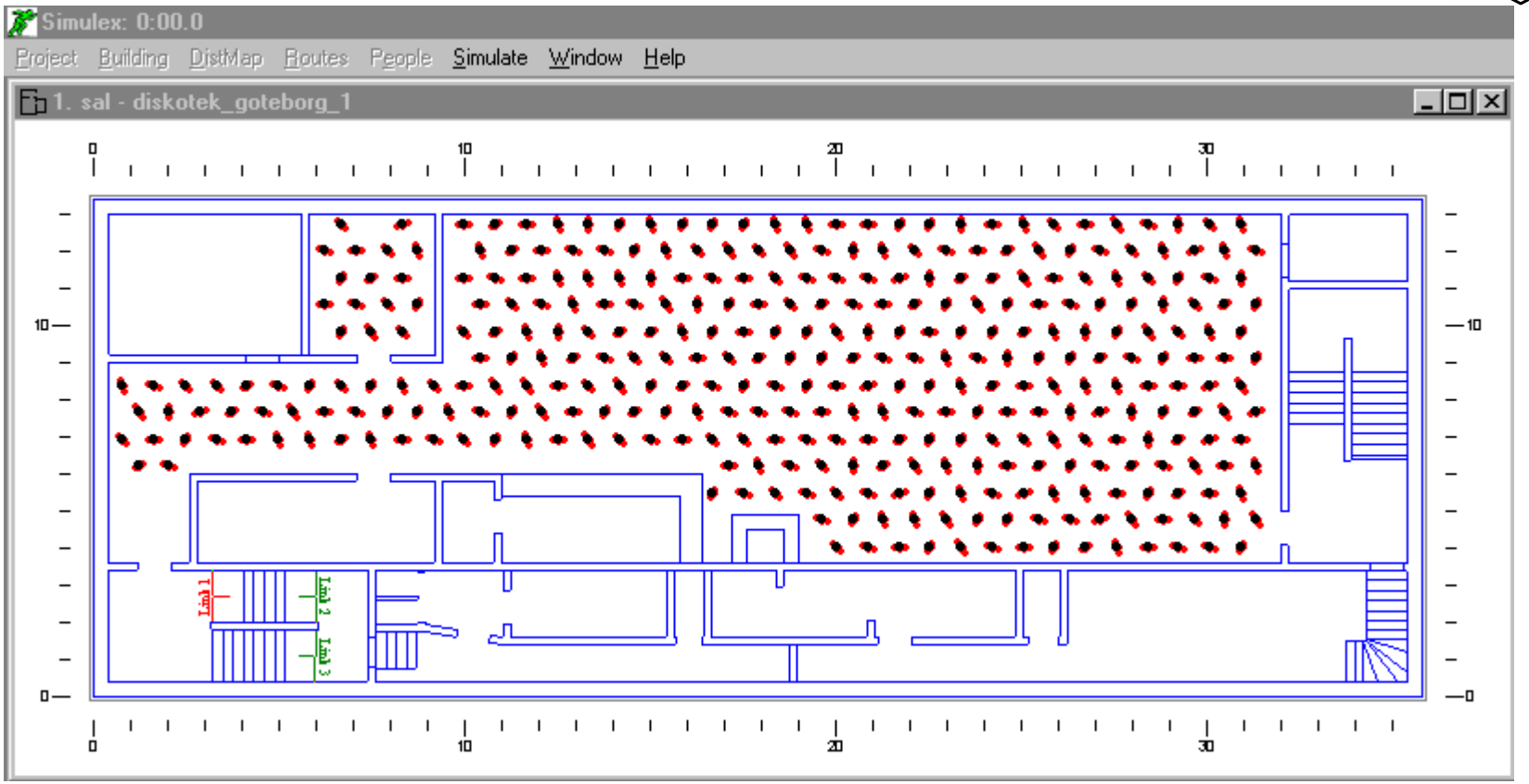
Simulation of evacuation



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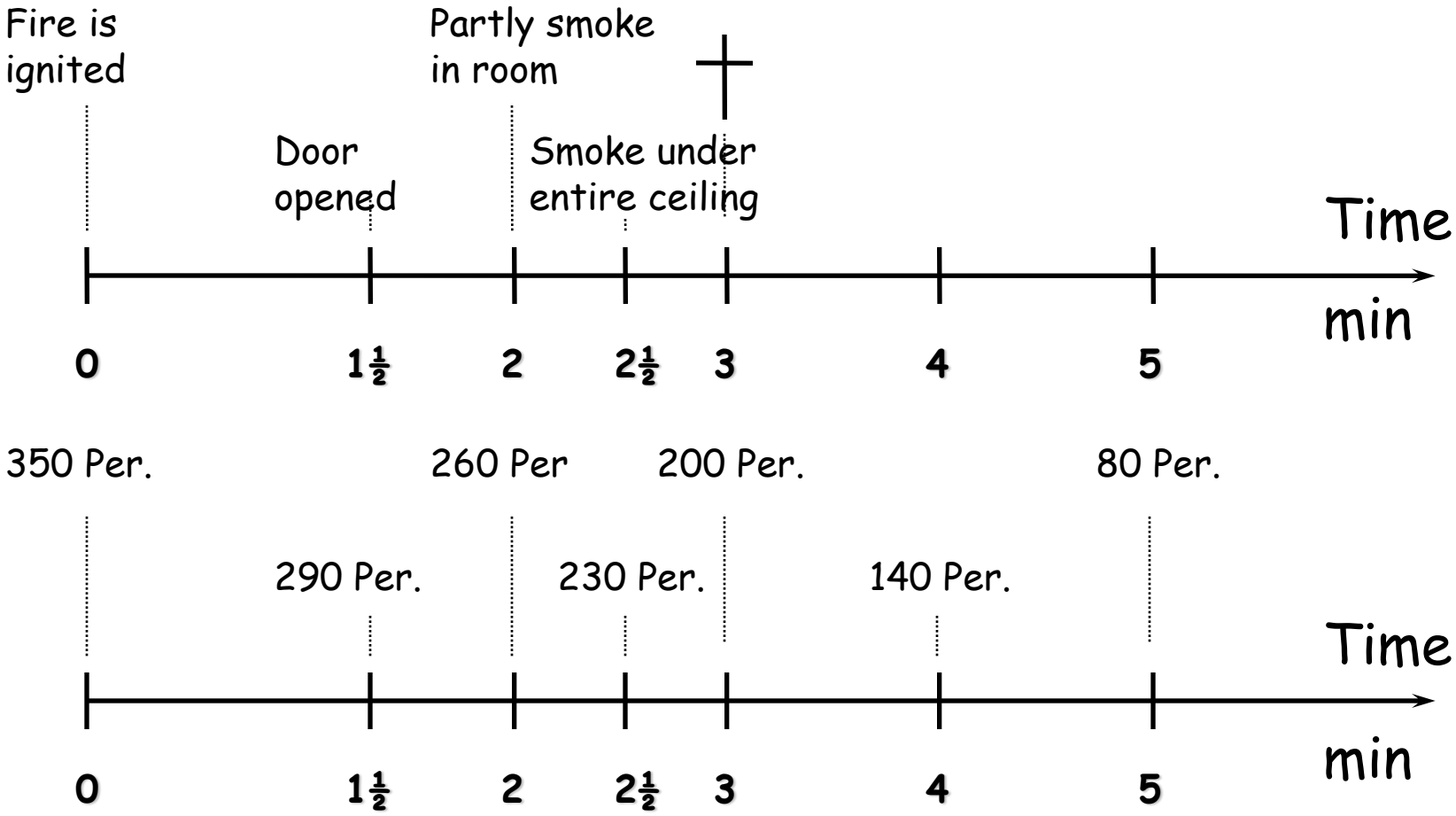
Time line fire and evacuation



Topdanmark Hallen in Ballerup, Denmark

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Topdanmark Hallen in Ballerup, Denmark

- Finished building, unprotected steel
- Only 50 persons on the field
- Maximum 1500 spectators along the facade
- Only sports

- The owner wanted to see if it could be used for other events (fairs etc.)

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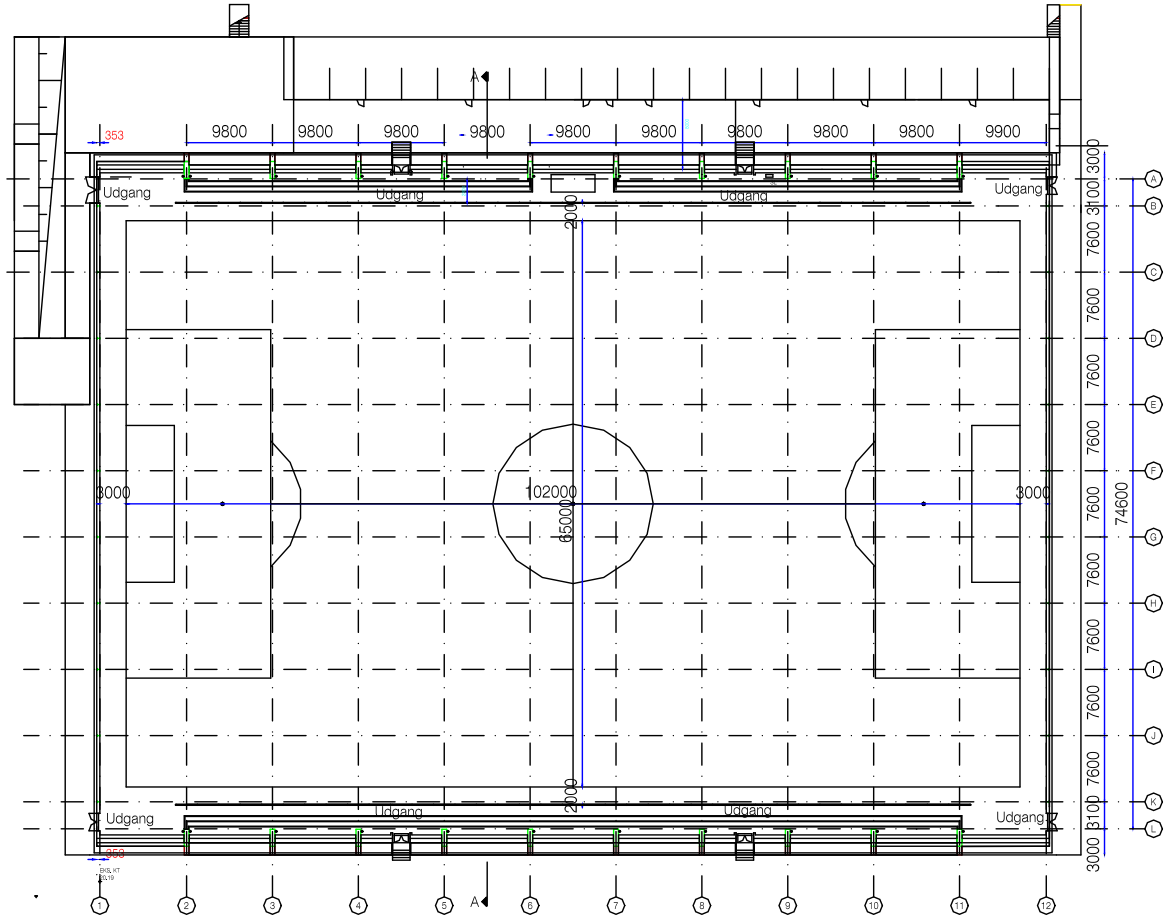
Floor plan Topdanmark Hallen in Ballerup, Denmark



Area 8230 m²

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Hand calculation, Topdanmark Hallen, Walking time

- Speed 1.2 m/s
- Maximum distance 40 m
- Walking time = 40 m / 1.2 m/s = 33 s
- 3500 persons
- Exit door, total width: 17 m
- Wanting time at doors = 3500/17 = 206 s

- Total walking time = 239 s

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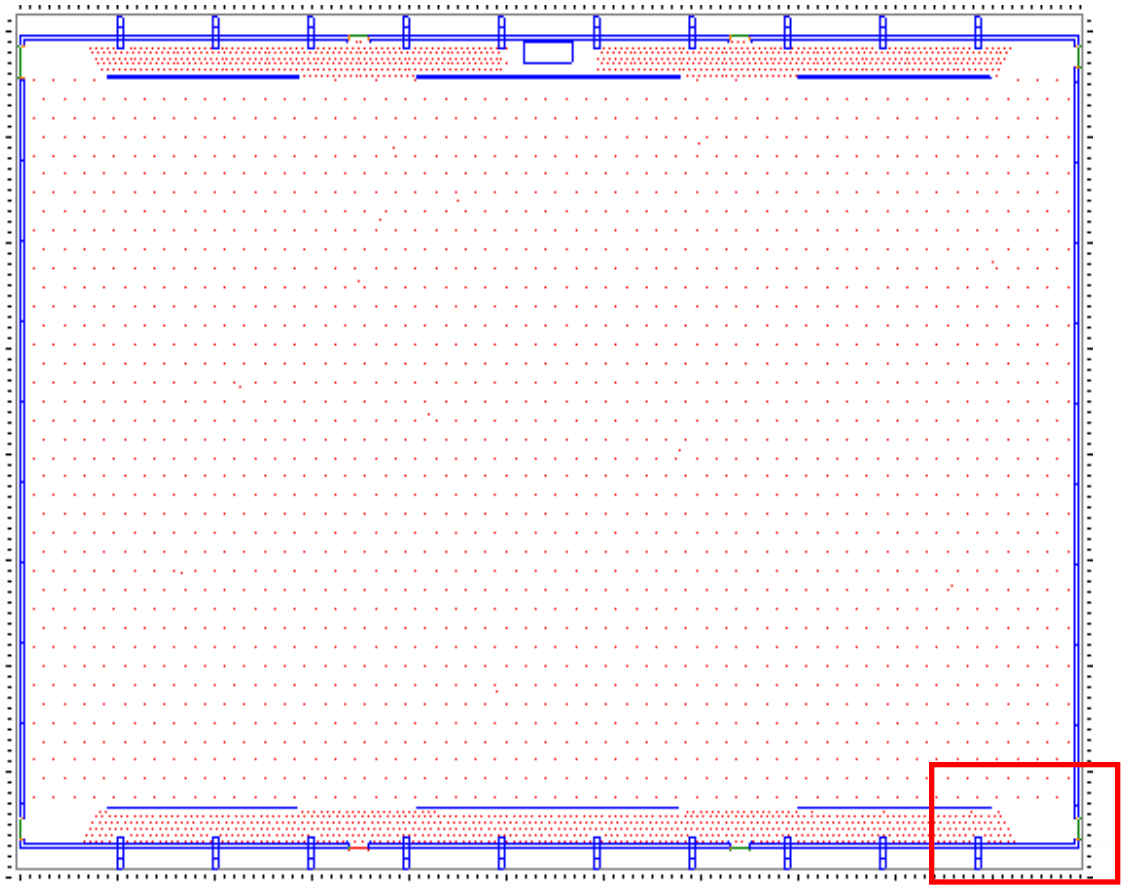
Simulex - Topdanmark Hallen



3500 persons

750 spectators on each side

2000 on the field

Geometry – dxf-fil (Autocad)

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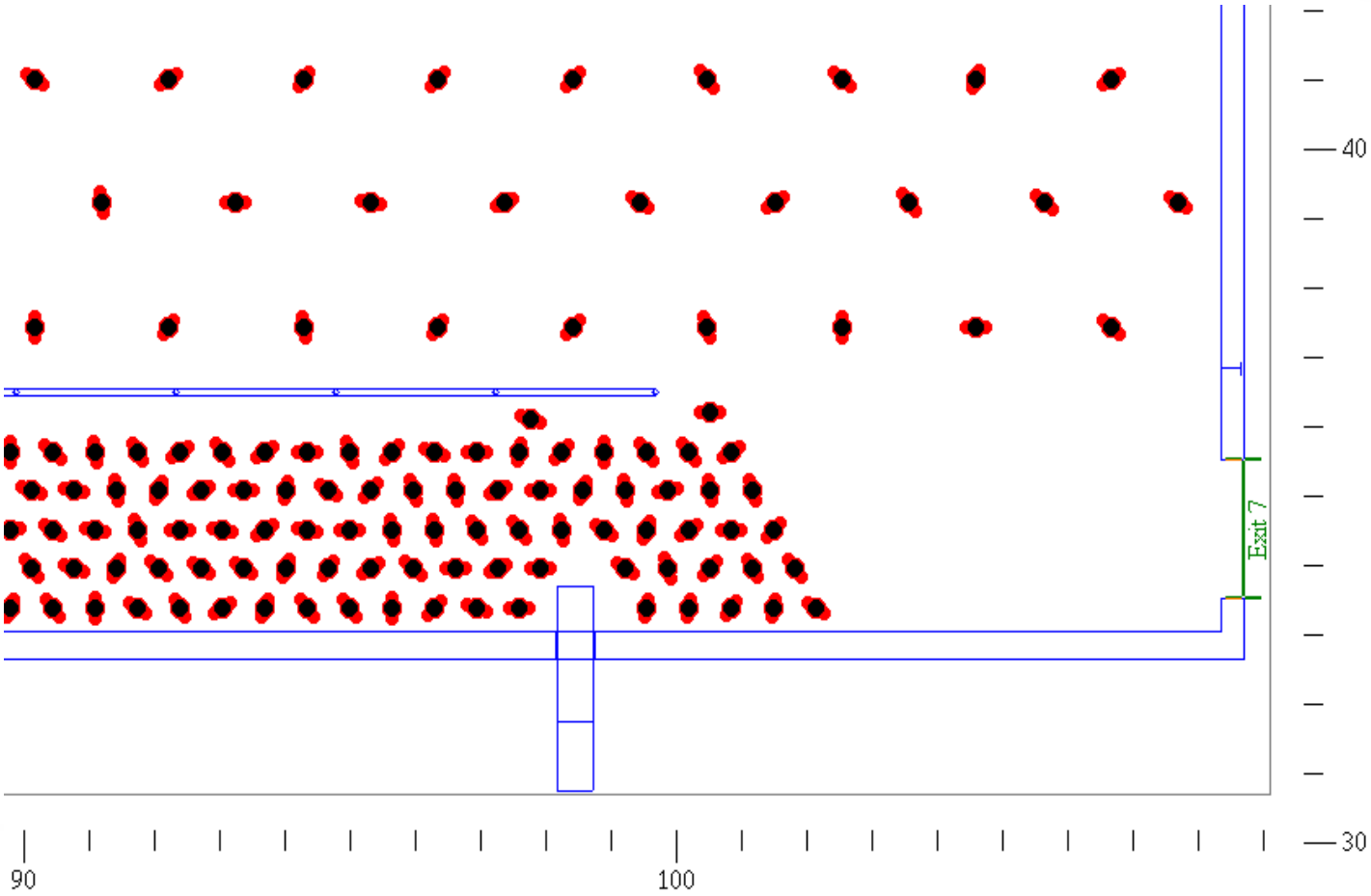
Simulex - Topdanmark Hallen



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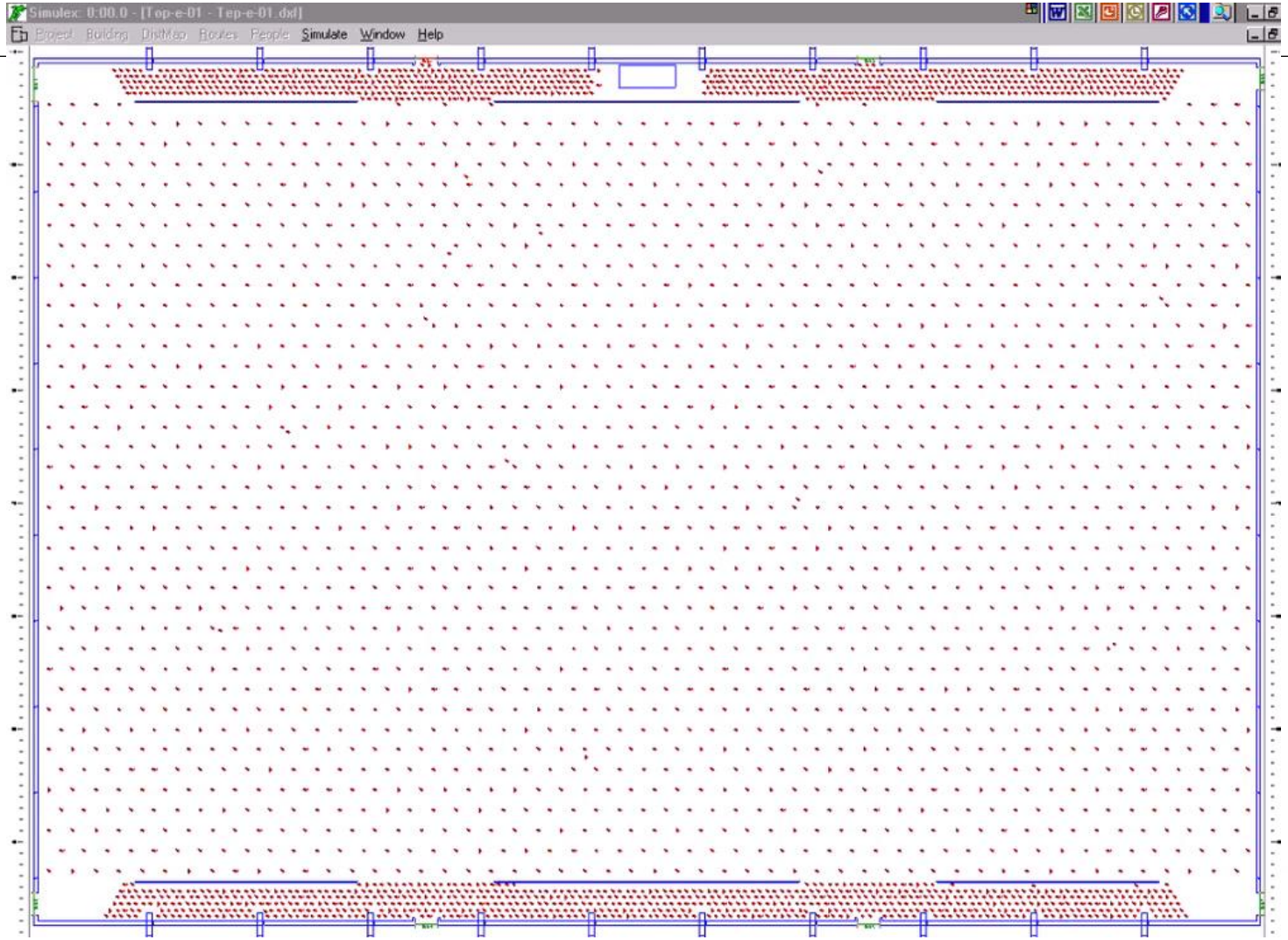
Simulex – Topdanmark Hallen



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Simulex - Topdanmark Hallen

- RSET (Time for evacuation)
  - Detection time (conservative): 180 s
  - Reaction- and decision time (conservative choice) 300 s
  - Walking time, simulex: 200 s

- Total time: 11:20 [min:s]

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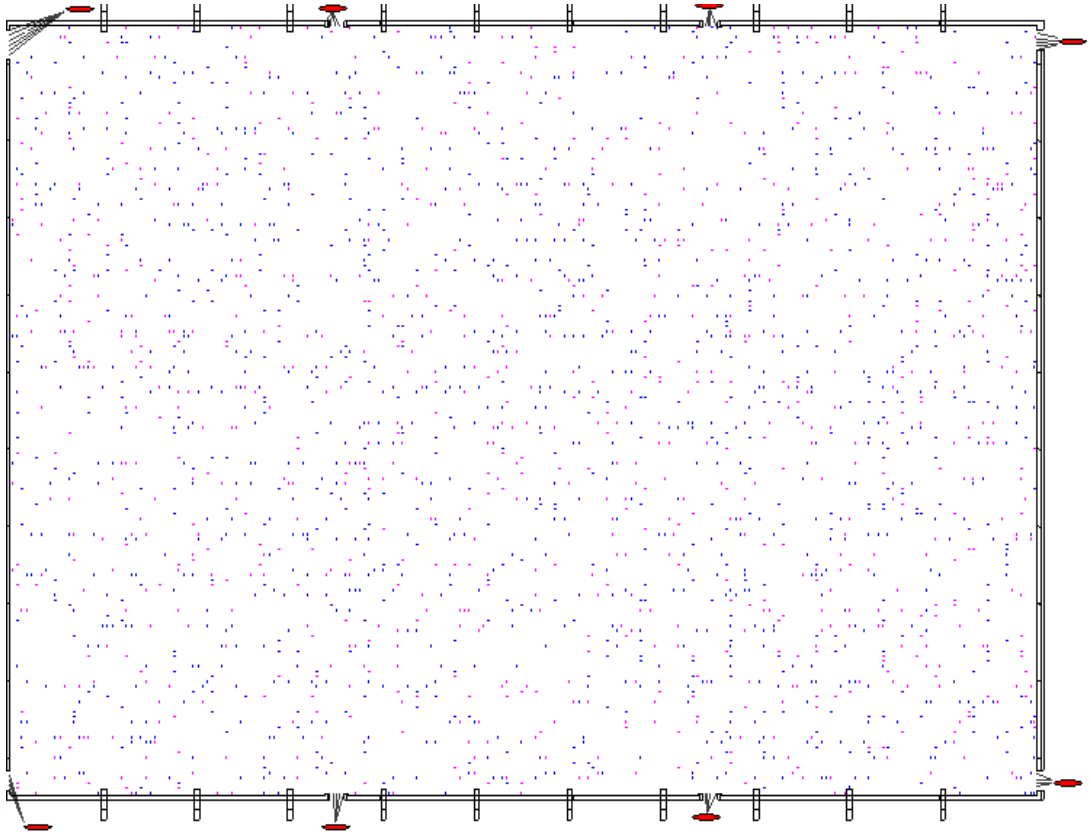
BuildingEXODUS – Topdanmark Hallen



3500 persons randomly placed

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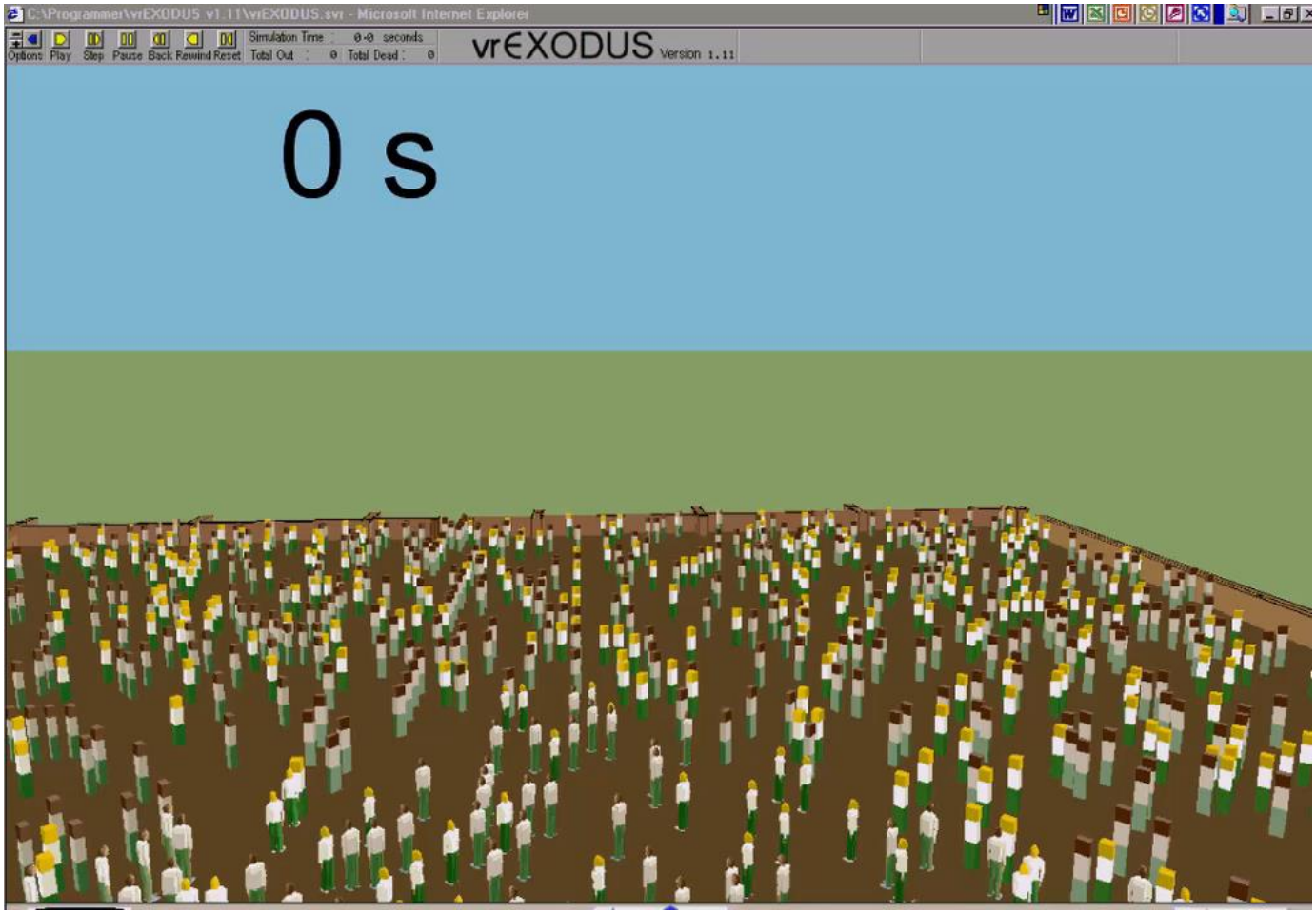
BuildingEXODUS – Topdanmark Hallen



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BuildingEXODUS - Topdanmark Hallen

- RSET (Time for evacuation)
  - Detection time (conservative): 180 s
  - Reaction- and decision time (conservative choice) 300 s
  - Walking time, EXODUS: 245 s

- Total time: 12:05 [min:s]

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Topdanmark Hallen in Ballerup

- Possibilities
  - Up to 3500 persons in the building
  - Flea market
  - Dog exhibition
  - Car -/flower shows
  - No concerts
- Additional requirements
  - Fire guard during large events
  - Audible alarm

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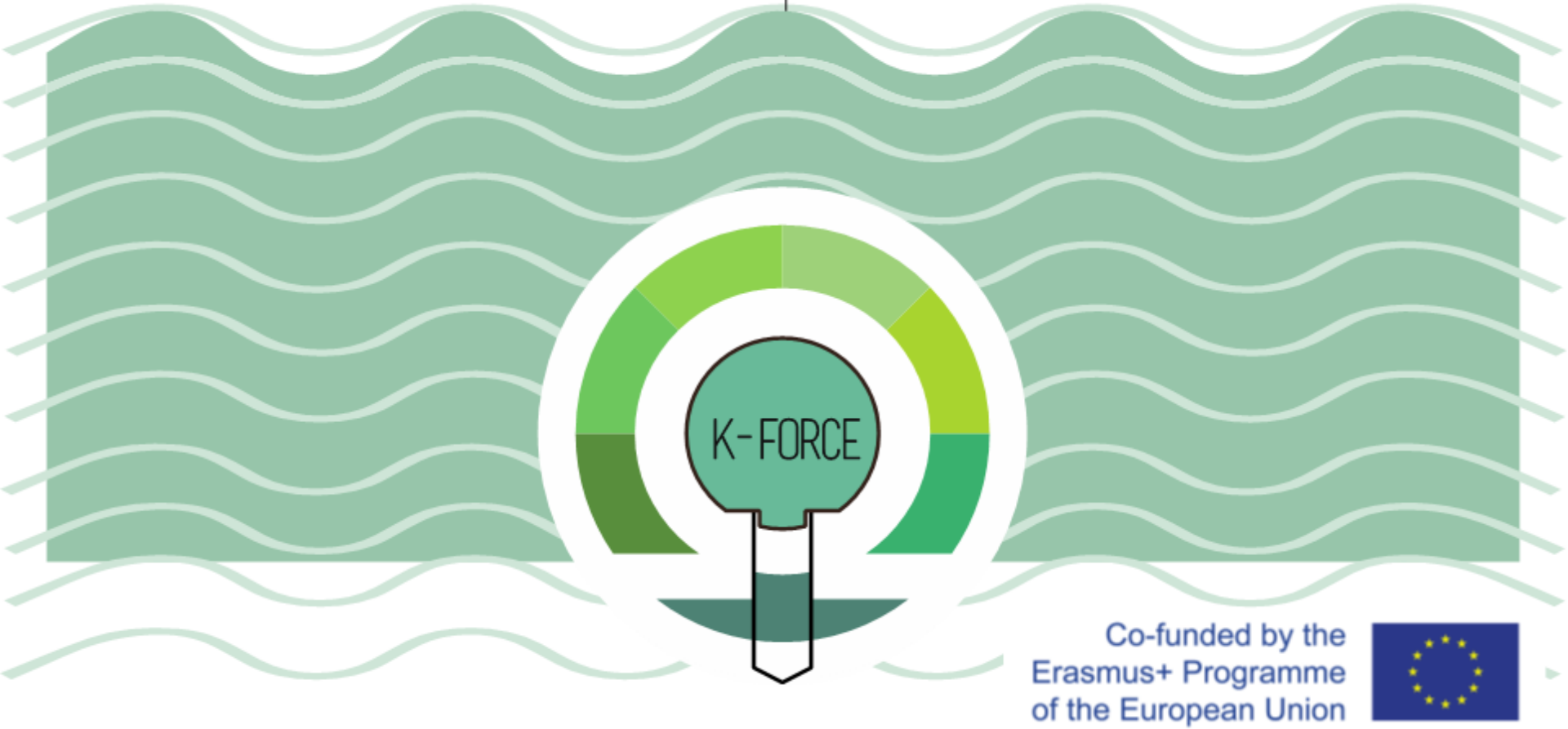

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Thank you
for your attention

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