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research facilities - FCC study collaboration, ESS

Evacuation modelling of the FCC facility

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Outline

- The modelling approach in use
- From simple to advanced evacuation modelling
- Evacuation scenarios
- Overview of results



The approach in use

Underground physics research facilities can have unique features from an evacuation perspective

- Combination of complex areas and simple tunnels
- Need for PBD methods come from:
 - 1) the possibly large size of the facility
 - 2) the possible behavioural interactions among evacuees
 - 3) the egress components available
 - 4) the varying degree of complexity of the geometric layout



The approach in use

- Too simple models may not be able to capture complex behavioural issues
- Too complex models may be unnecessary for the simpler parts

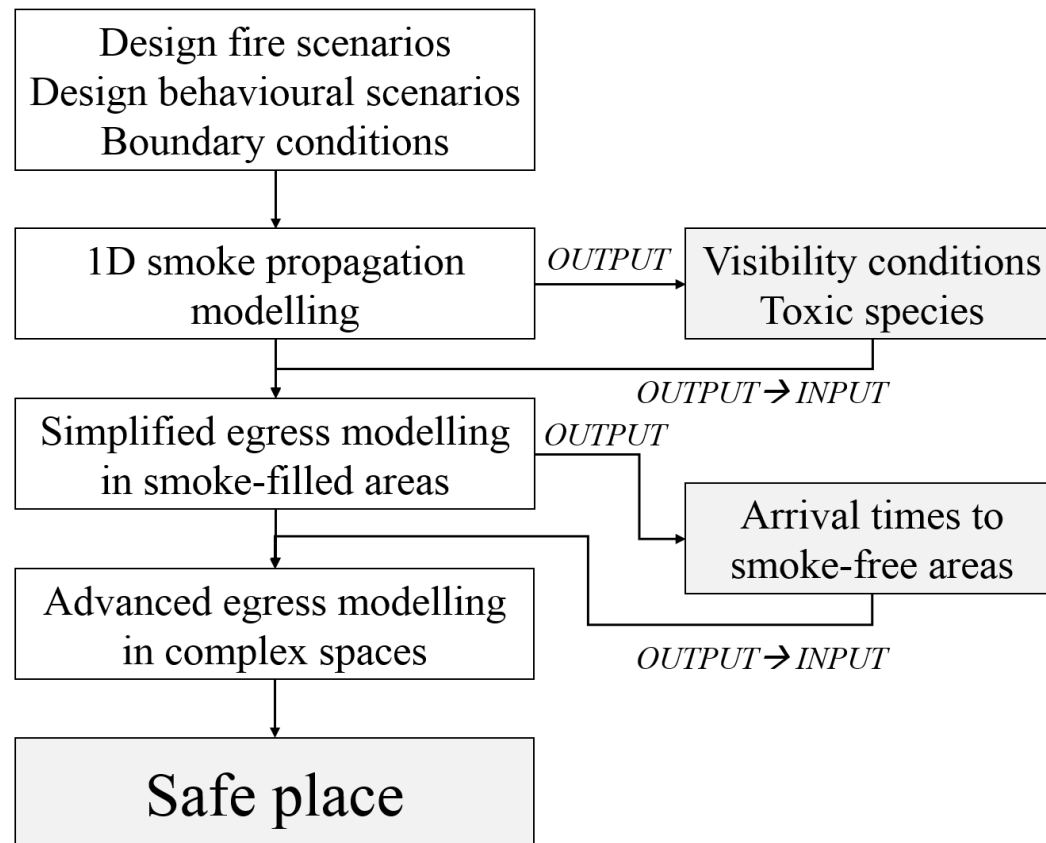
IDENTIFICATION OF A NEW EVACUATION MODELLING WORKFLOW

SIMPLIFIED MODELLING
+
ADVANCED MODELLING



From simple to advanced evacuation modelling

Evacuation Modelling Workflow



From simple to advanced evacuation modelling

Evacuation Modelling Workflow

Smoke propagation calculations

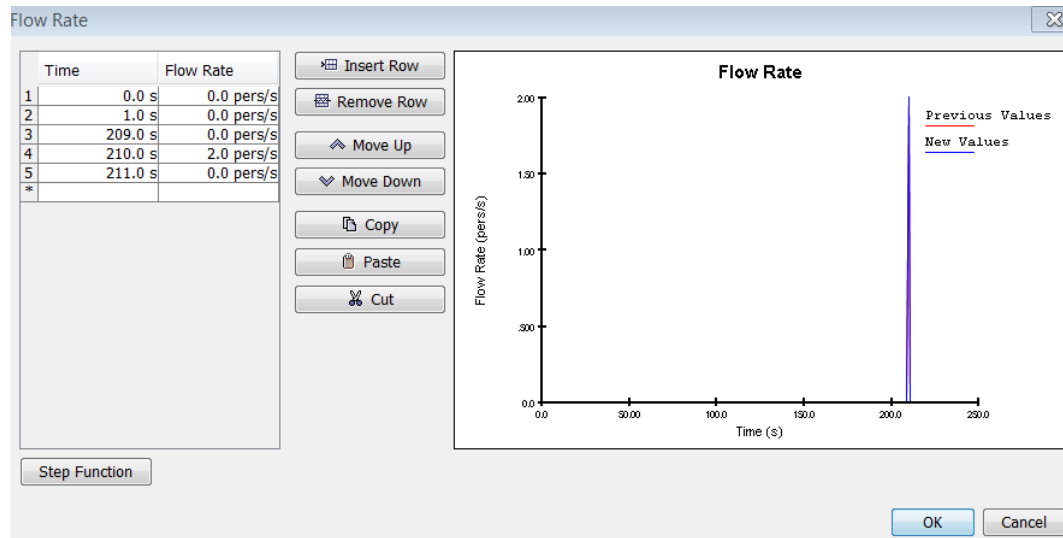
People implemented in simple 1D evacuation model

Occupant sources used to implement people in Pathfinder

Horizontal movement in smoke-filled tunnel

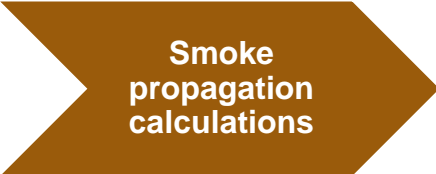

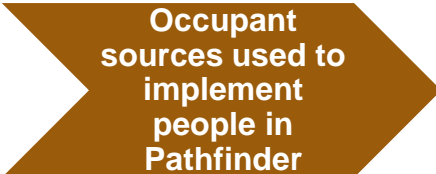
Movement in smoke-free tunnel
Use of elevators

EVACUATION RESULTS
(occupant / evacuation time curves from Pathfinder, LoS, FED from simple model)



From simple to advanced evacuation modelling

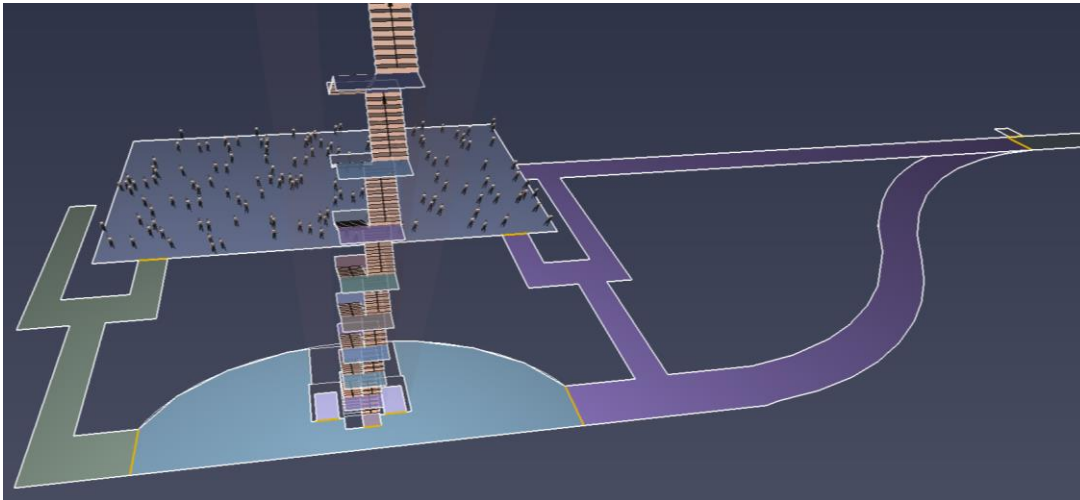
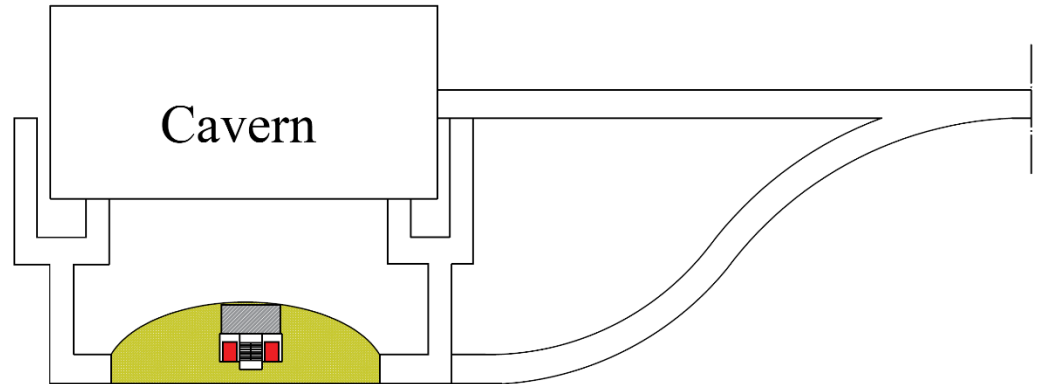
Evacuation Modelling Workflow

- 1**  **Smoke propagation calculations**
Equations based on Ingason, 2015
- 2**  **People implemented in simple 1D evacuation model**
Probabilistic representation
Movement is affected by smoke based on Fridolf et al, 2016
FED calculations (based on Purser)
Possible to study victims/injured
- 3**  **Occupant sources used to implement people in Pathfinder**
People use transportation means (implemented with speed factors)
People reach the elevator lobby
People use elevators and reach the surface



Evacuation scenarios

Geometric layout



Evacuation scenarios

Model inputs

Variable	value
Length of the single arc	10 Km
Max depth	400 m
Number of people	50 (arc) + 150 (cavern)
Transportation speed	20 Km/h
Pre-evacuation times	60-120 s for cavern (98%); 180 s for movable platform (2%)
Initial walking speed	0.9 m/s (this can be affected by smoke in the simplified model)
Sections	63 sections of approx 160 m (due to firefighters operation), homogeneous distribution of people

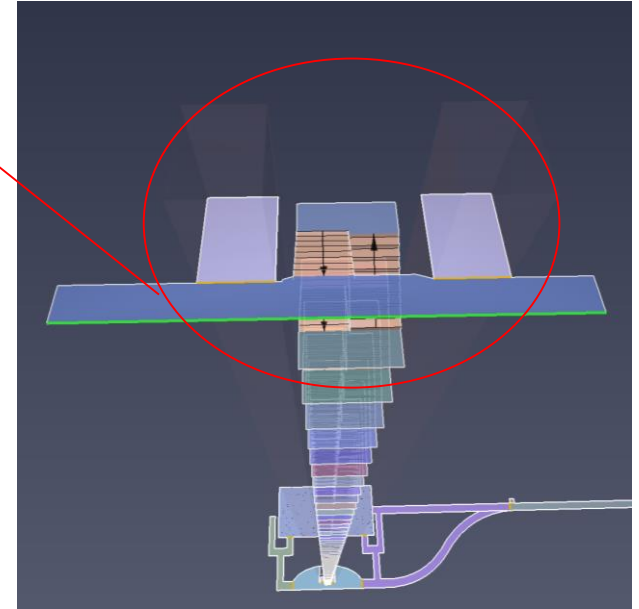


Evacuation scenarios

Model inputs

Ground level

Elevators	value
Speed	4 m/s
Max acceleration	0.67 m/s ²
Capacity	Max 35 people (conservative estimate from 38)
Open and closing time of the doors	15 s



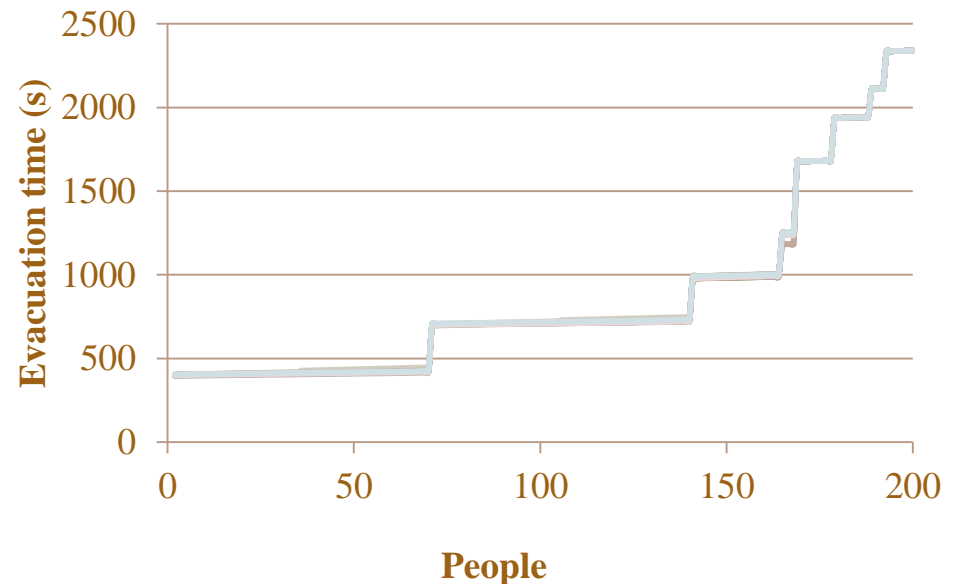
Implicit representation of 1 elevator journey used for firefighters intervention (after 20 min)



Overview of results

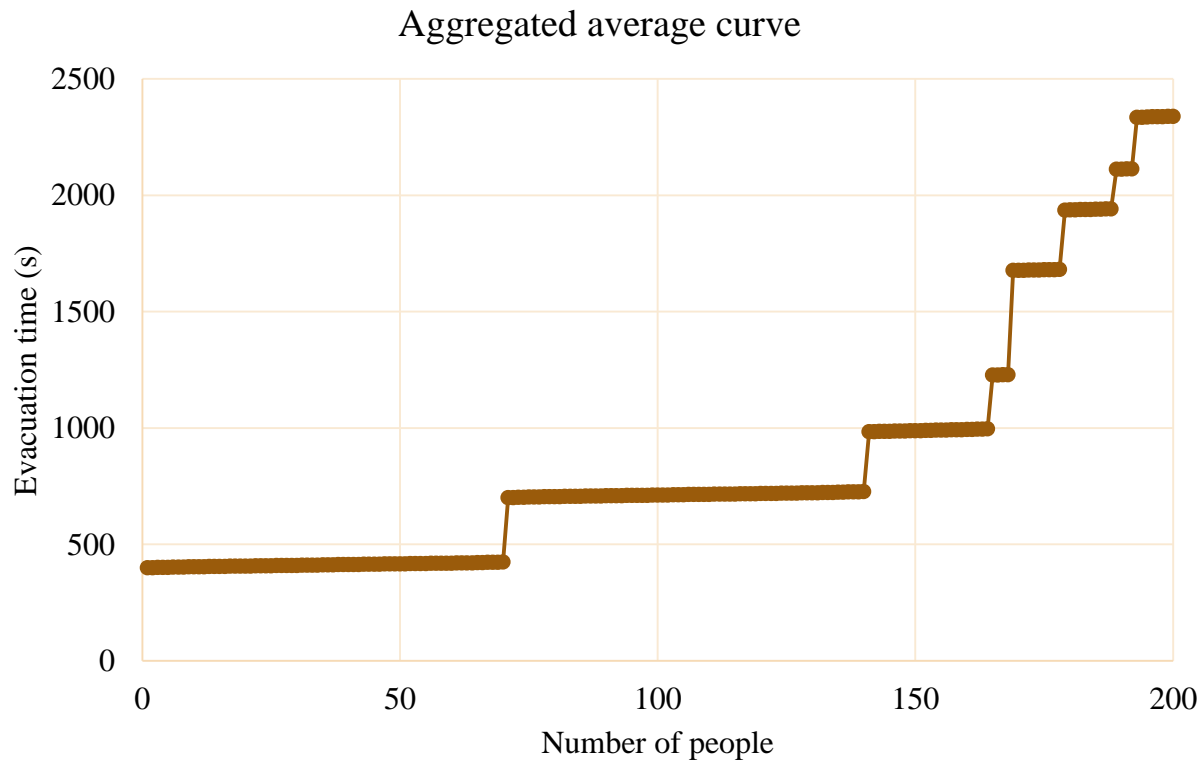
Simulations

- Multiple simulations to account for variability of behaviours
- Convergence criteria based on functional analysis operators and evacuation times (TET, SD, ERD, EPC, SC), see Ronchi et al, 2013 with min 15 runs



Overview of results

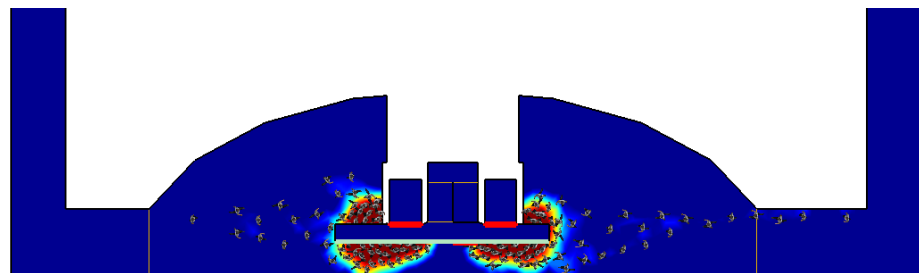
Simulation results



Overview of results

Simulation results

- Evacuation completed in less than 40 min. Time is higher than original lift calculations because we accounted for the loss of one elevator journey (due to firefighter intervention)
- Quite rapid convergence of results (due to elevators)
- Results are mostly driven by the elevator journeys and waiting times in the lobby
- No high densities are reached in the lobby with the given configuration (dimensioning seems fine)



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THANK YOU!

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