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Evacuation with Elevators - Current Activities

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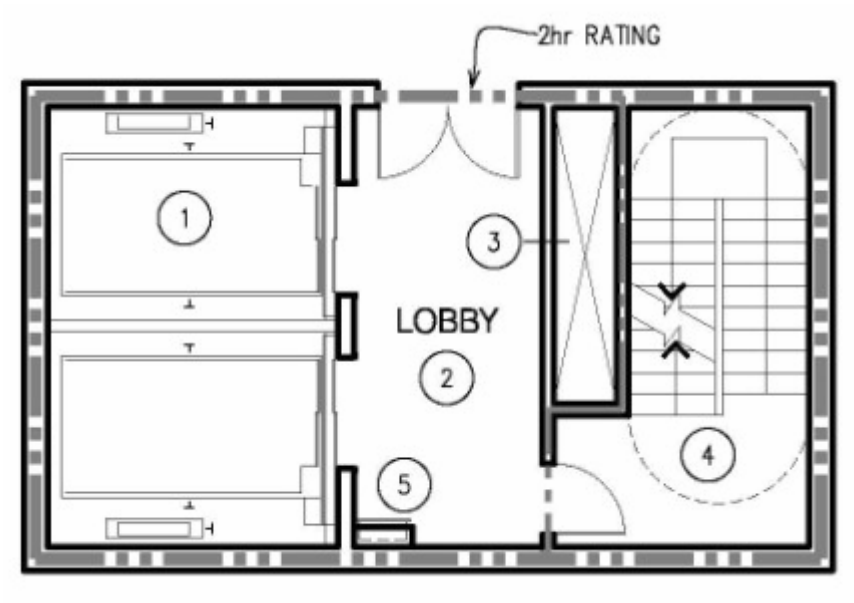
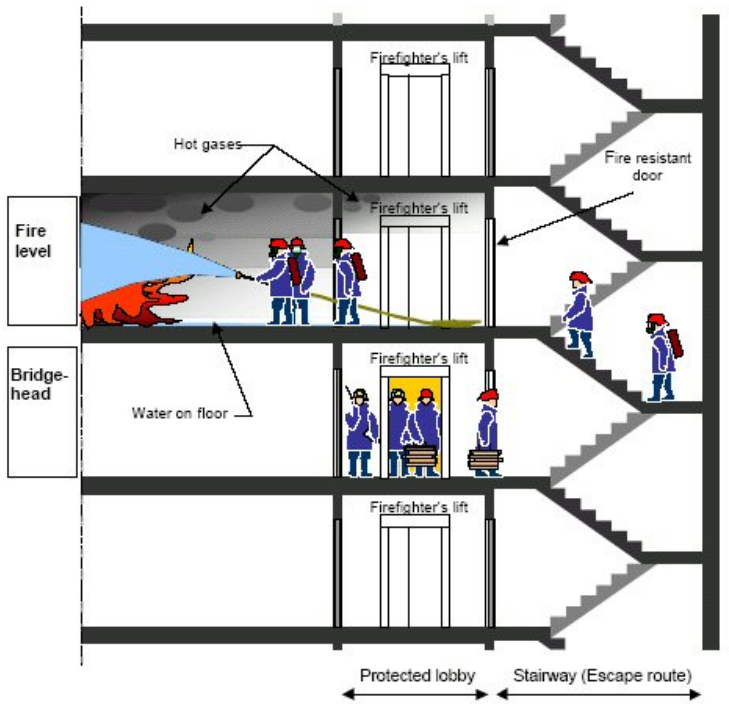
- *Activities in Europe and USA*
- *Other Activities*

Actual situation in Europe: EN 81-72

- Today two standards have been published
  1. EN 81-72 which defines *requirements for fire-fighter lifts*





Actual situation in Europe: EN 81-73

2. EN 81-73 which defines requirements concerning the *behaviour of lifts in case of fire*

- *Fireman's service mode*
  - Phase I: Elevators returned to rescue floor by a fire detection signal
  - Phase II: Manual operation in fireman service mode (National Building Regulations)

Actual situation in Europe: A Europe accessible for all

- A group of experts set up by the European Commission published in October 2003 a report ***"2010 : A Europe accessible for all"*** that stipulates:

"An accessibility for all European standard on design, construction and use of building, should be developed, including provision on fire safety and means of evacuation for people with disabilities"

"In 1999, 18% of the EU's total population reported "severe" or "moderate" impairment in their daily lives, of whom 7% reported being "severely disabled" "

UNDER STUDY

CEN TC10 WG6
Evacuation of Disabled People

- The principle “DO NOT USE ELEVATORS” is not modified
- The working document prEN/TR81-76
  - Under study the conditions for the evacuation of disabled persons (persons with impaired mobility)
  - Describes only a simple evacuation lift in low and mid rise building as offices, shopping centres, hotels, residences…
  - Out of the scope of this study are demanding buildings such as high rise buildings (more than 25 floors), hospitals, houses for retired people, buildings with permanent fire-fighters where a more sophisticated approach has to be taken
- Co-operation between CEN TC 10 and CEN TC 127 *(Fire safety in building)*

ASME - FEO
Firefighter's Emergency Operation

- ASME A17.1 in mid-1980's and recommended for retrofit to all elevators
- Activated by smoke detectors in every lobby and in the machine room, or other fire alarm systems
- Initiates Phase I recall to designated floor
  - Elevators out of service with doors open
- Fire service can use key to activate Phase II, utilizing modified functionality of in car controls

FIRE OPERATION

When 	Flashes, exit elevator
To operate car	Insert fire key and turn to "ON." Press desired button.
To cancel floor selection	Press "CALL CANCEL" button.
To close power-operated door	Press and hold "DOOR CLOSE" button.
To open power-operated door	Press and hold "DOOR OPEN" button.
To hold car at floor	With doors open, turn key to "HOLD."
To automatically send car to recall floor	Turn key to "OFF."

ASME
Proposed Arrangement for Access Elevators

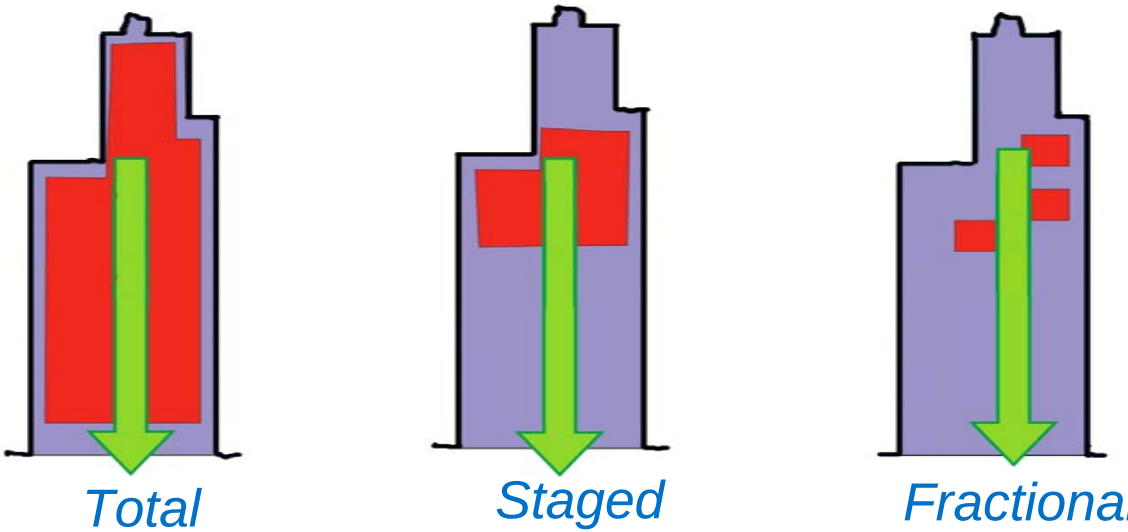
- FEO retained
- Elevator serving every floor recalled on any alarm to await fire service
- Additional monitoring of lobbies, machine room, and controller from fire command
- Enclosed lobbies protect hoistway from water and smoke, and provide staging area

ASME
Proposed Arrangement of Occupant Egress Elevators

- FEO retained
- **Additional monitoring of lobbies, machine room, and controller from fire command**
- **Enclosed lobbies protect hoistway from water and smoke, delay Phase I, and provide protected area to wait**
- **Special evacuation operation (Phase III)**
  - Evacuate building from top down; shuttle from floor to egress level (begins on order of incident commander for full evacuation)

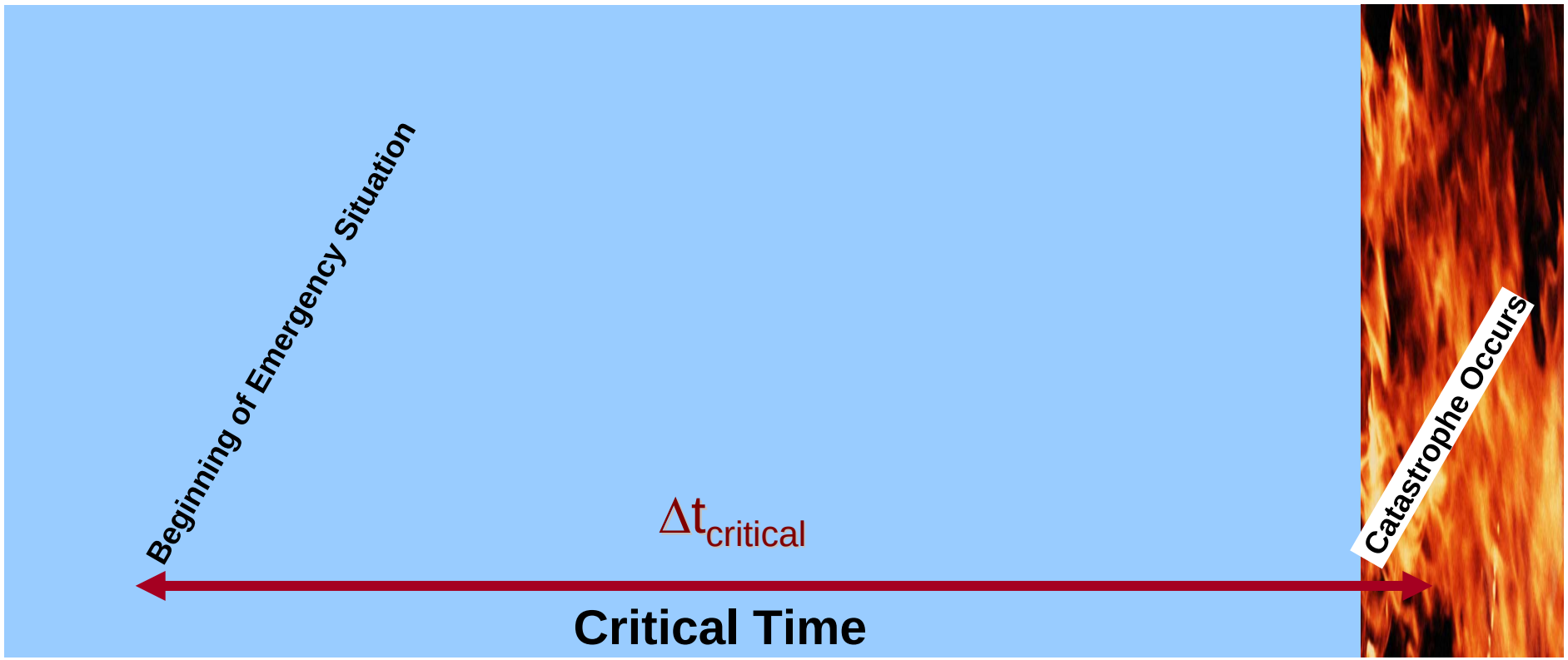
- *Activities in Europe and USA*
- *Other Activities*
  - *Evacuation Mode*
  - *Evacuation Time*

KONE approach
Non-Fire evacuation mode

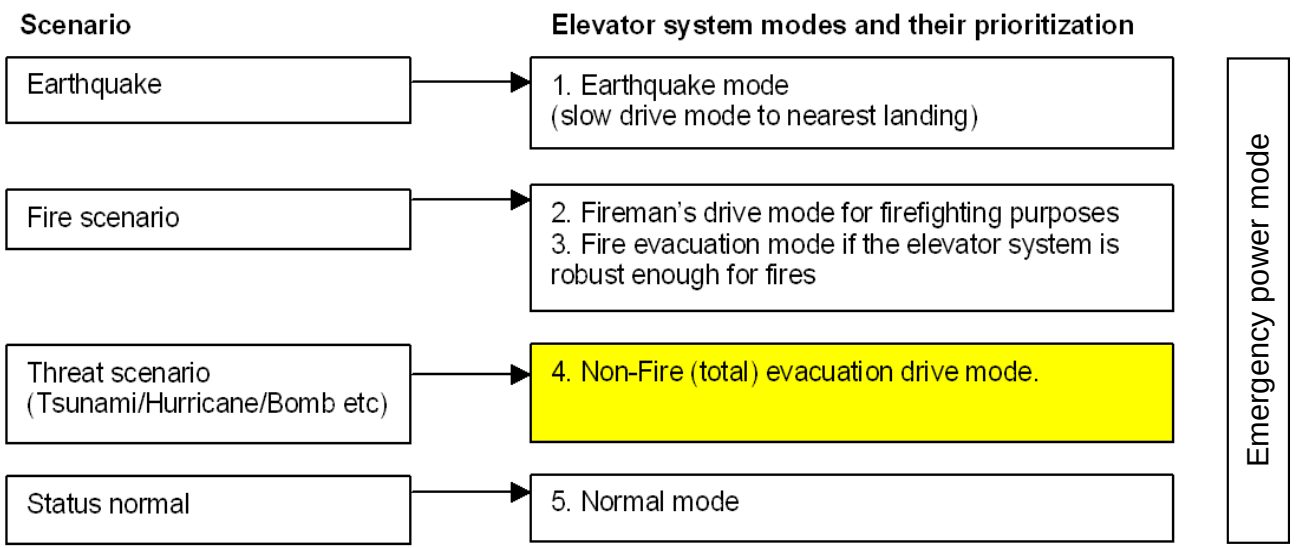


- KONE control systems include non-fire emergency (bomb threat, electricity break, hurricane etc.) evacuation mode
  - All or selected elevator groups, escalators and stairs are used in evacuation
  - Automatic collective elevator control, car calls only to emergency exit floor accepted

Evacuation Phase I



KONE Non-Fire evacuation mode
Mode Priorities



Upper priority modes override the lower priority modes

- 1. Earthquake mode (EAQ)
- 2. Fireman's drive mode (FRD)
- 3. Fire evacuation mode (EN81-76 under study)
- 4. Non-Fire evacuation mode
- 5. Normal drive mode

In Emergency Power Drive mode (EPD) mode operational elevators in group are defined

- *Activities in Europe and USA*
- *Other Activities*
  - *Evacuation Mode*
  - *Evacuation Time*

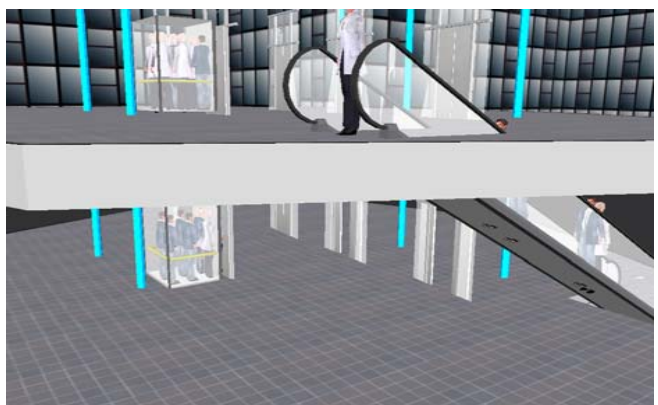
Research on Evacuation Time

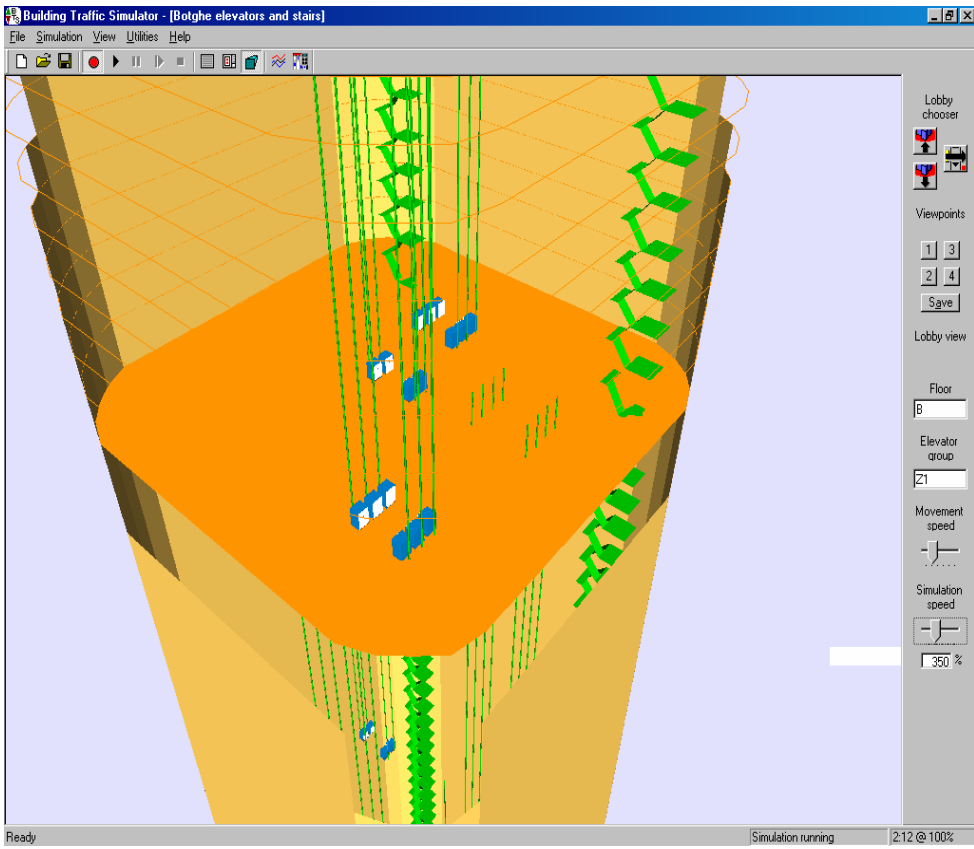
- Human behaviour (G. Proulx)
- Human factors (J. Pauls)
- Modeling of horizontal people flow (National Research Centres and private companies)
- Vertical people flow (elevator companies, consultants)

Possible Evacuation Times

Used evacuation time criteria:

- Office buildings and hotels < 30 min
- Mega high rise buildings < 60 min
- Residential buildings < 40 min
- Shopping centres, stadiums, metro stations airports, etc. < 60 min

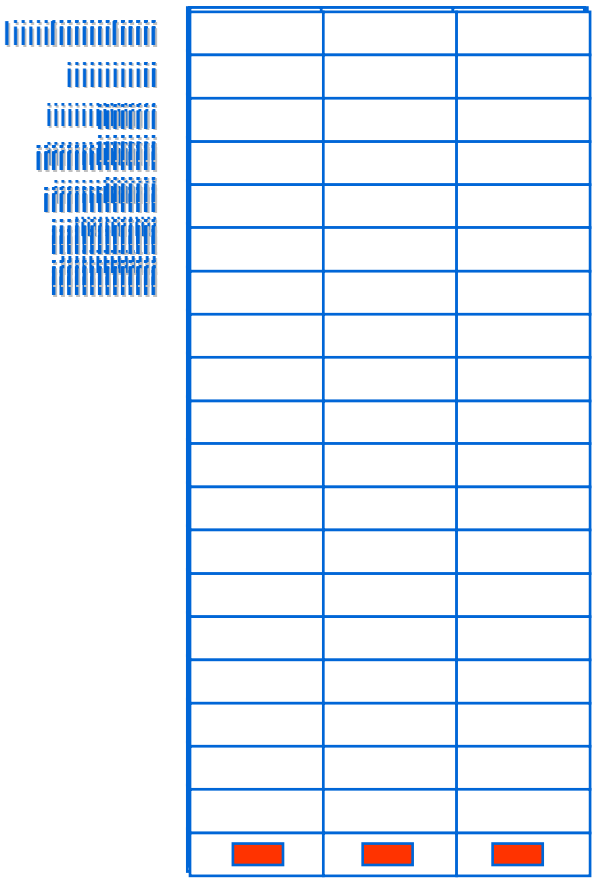




Egress Time with Elevators

$$T_{elevatoregress} = [\sum_{i=1}^{N_{RT}} (2H_i t_v + 2t_s + 2M_i t_m)\ ] / N$$

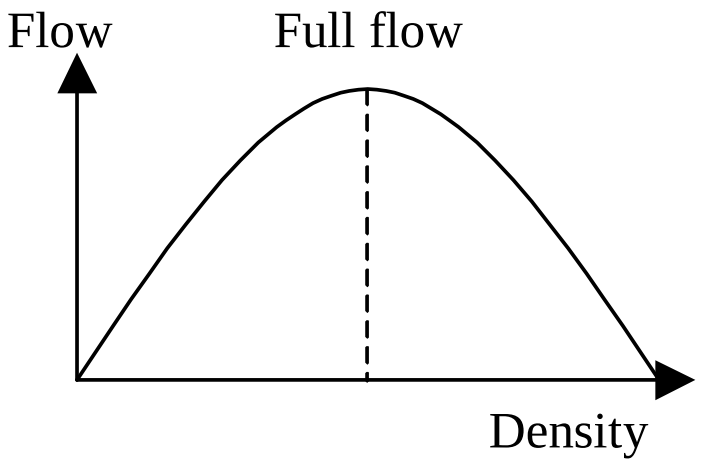
- where N_{RT} = population/ car capacity
- N = number of elevators
- H = reversal floor
- M_i = load in persons
- t_v = one-floor travel time =h/v
- t_s = stop time (acceleration, deceleration,door times,photocell, start delay)
- t_m = passenger transfer time



Egress Time with Stairs

- Handling Capacity in a staircase in persons per minute

$$C = 0.83(60\,vD\,W)$$



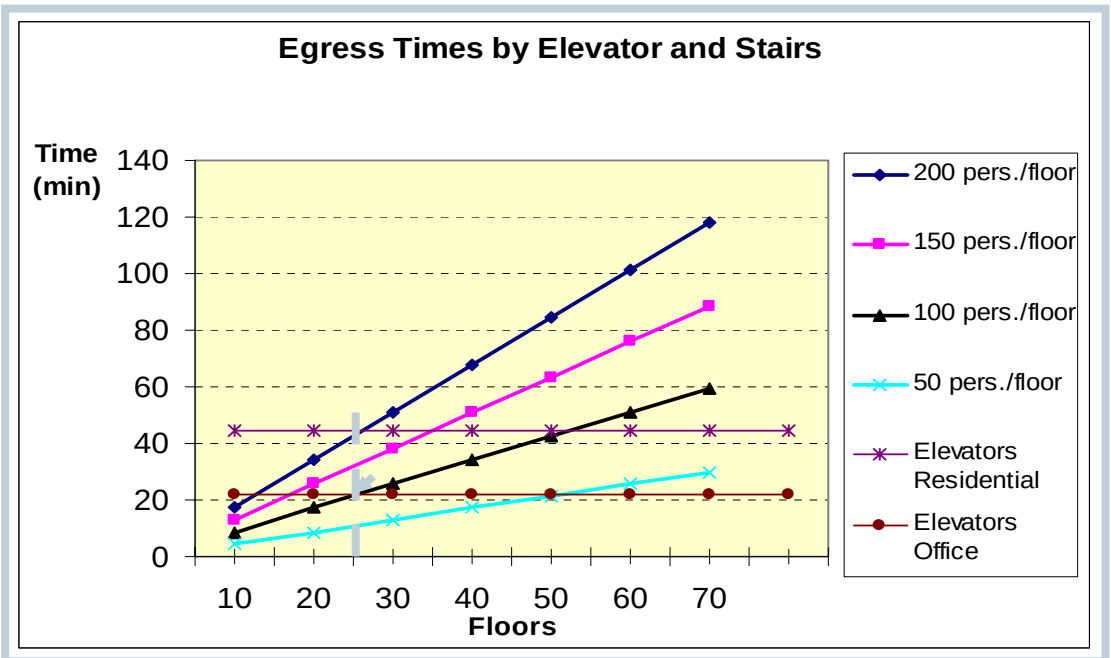
  - v = average walking speed (0.6 m/s)
  - D = people density (2 persons/m^2)
  - W = effective width of the stairs in meters

- Egress time is the population divided by the Handling Capacity and number of staircases (L)

$$T_{Stairsegress} = Population\ /C/L$$

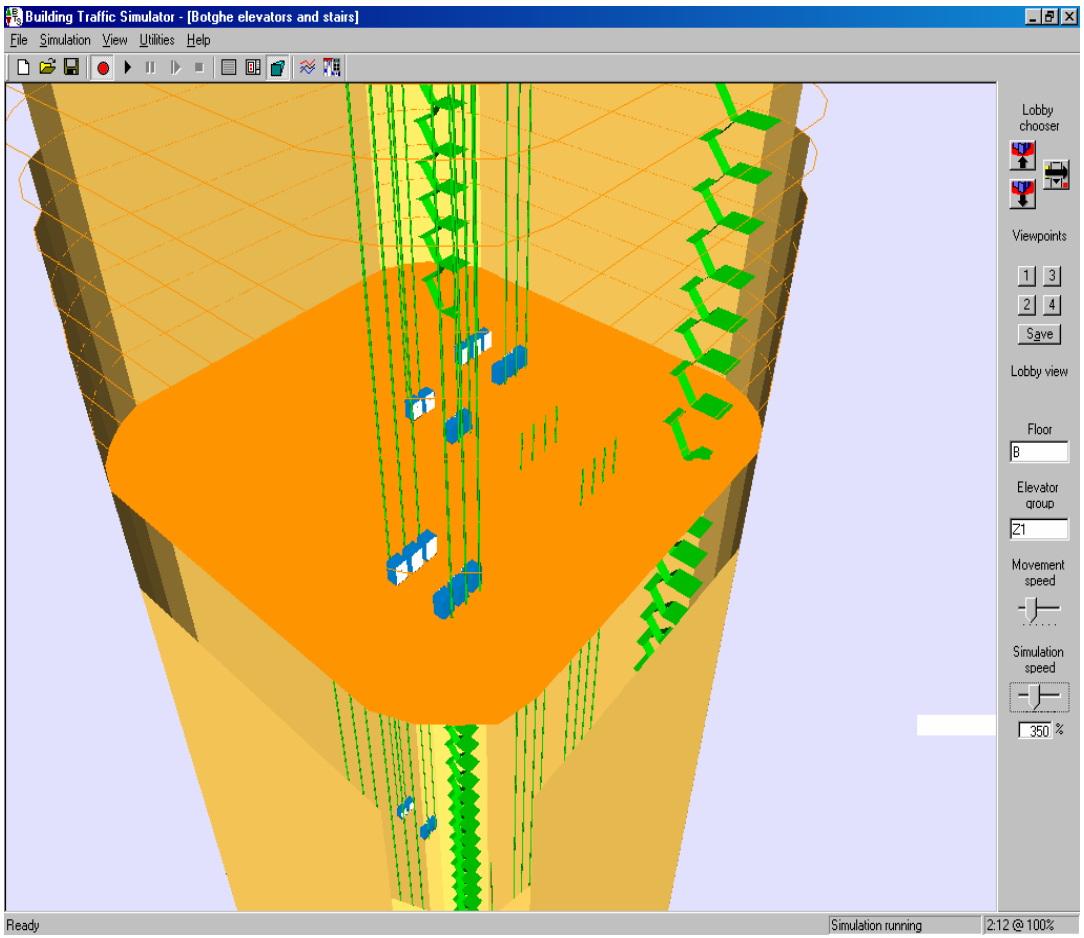
Evacuation Time with Direct Access to Main Lobby

- Egress time with two staircases increases by the number of served floors
- Egress times with elevators are independent of the number of floors for a certain handling capacity
  - In office buildings egress time 22 min (42 min in residential buildings)



Evacuation Time in Mega High Rise Buildings Case Study

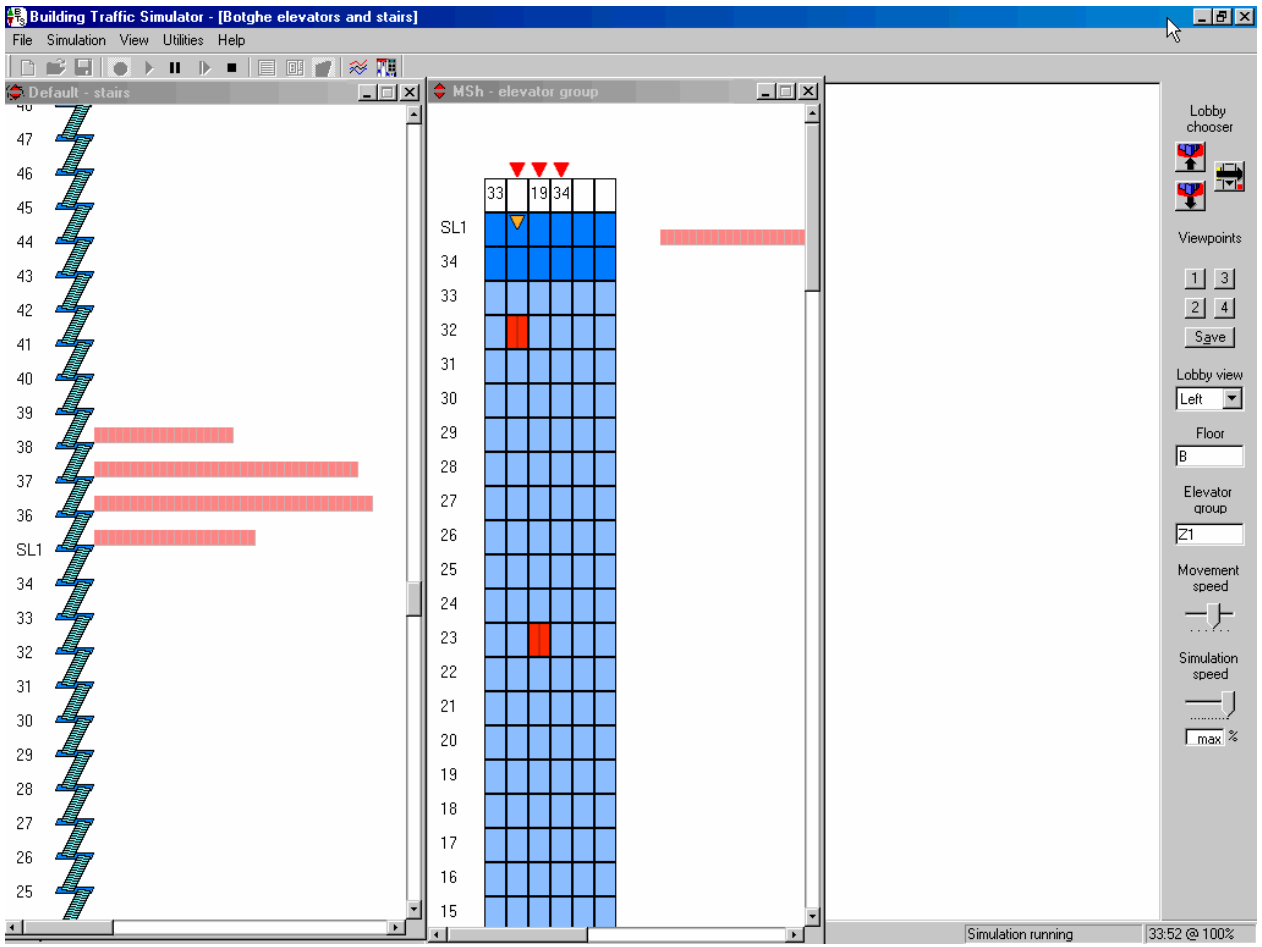
- number of floors 88
- 10 700 persons
- 9 elevator groups
  - 7 local groups
  - 2 shuttle elevator groups
- two 1400mm wide staircases



Case study of generic evacuation scenarios

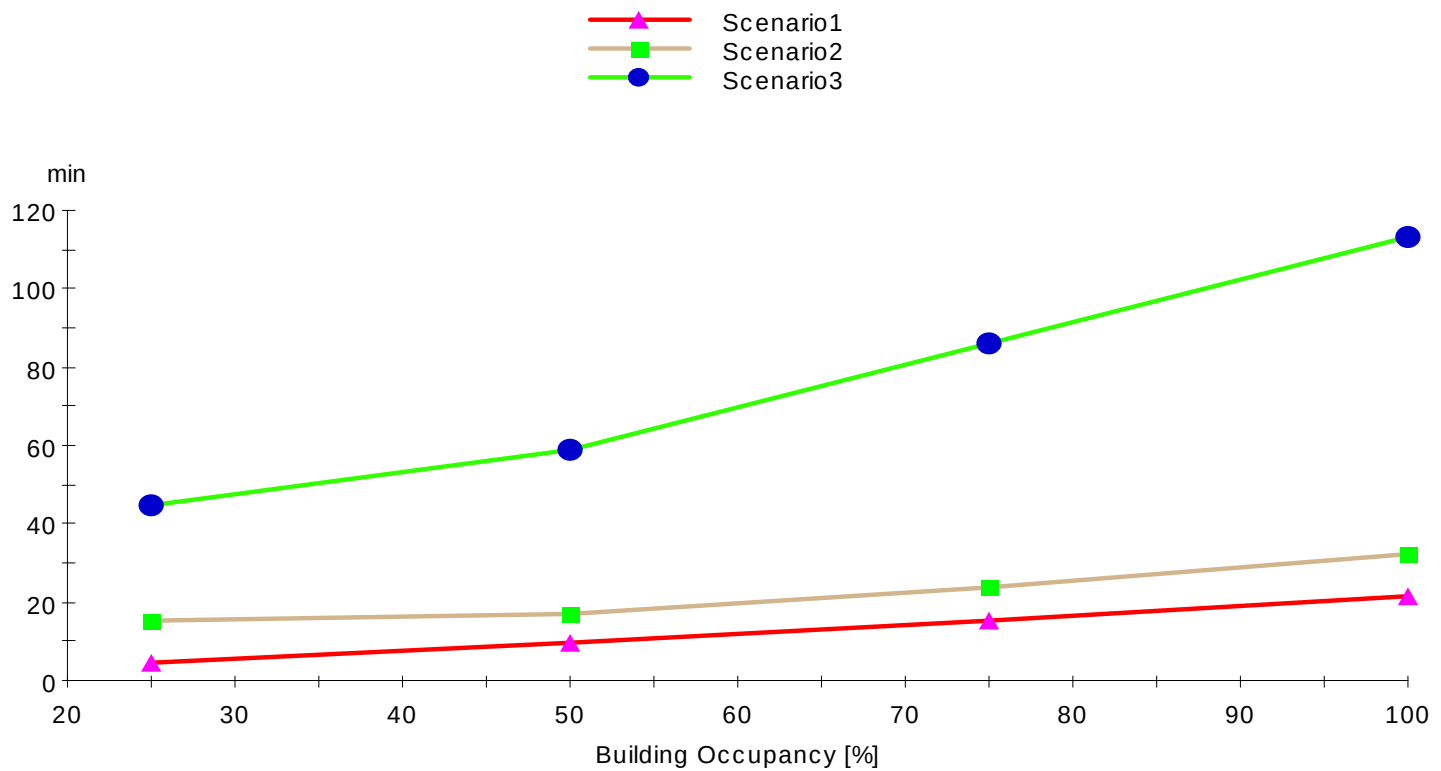
1. All passengers use elevators (self-evacuation)
2. Passengers use protected shuttle elevators and staircases
3. Passengers use mostly staircases and European type firefighters' protected elevators

Evacuation simulation using elevators and shuttle elevators



Simulation results

Egress time: 1) Elevators, 2) Shuttles and Saircases, 3) Staircases



Summary

- CEN TC10 WG6
  - Concentrates on evacuation of disabled people
  - Low and Mid Rise buildings
- ASME
  - Total occupant evacuation (Phase III)
  - No restriction in building height

- The combined use of elevators and staircases for evacuation is fast and economically feasible
- In non-fire situations standard elevators can be safely used for total evacuation with additional detectors
- Total evacuation in fire situation requires enhanced or protected elevators

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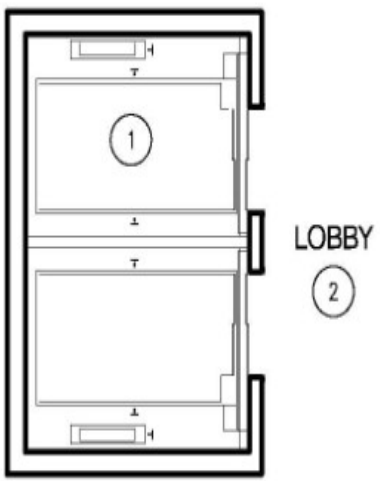
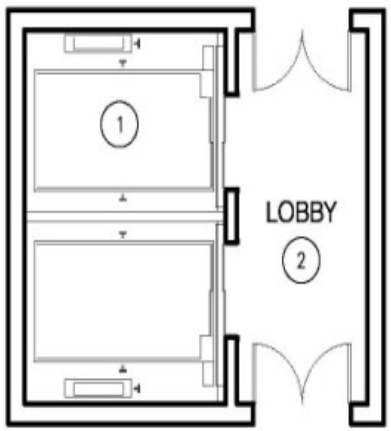
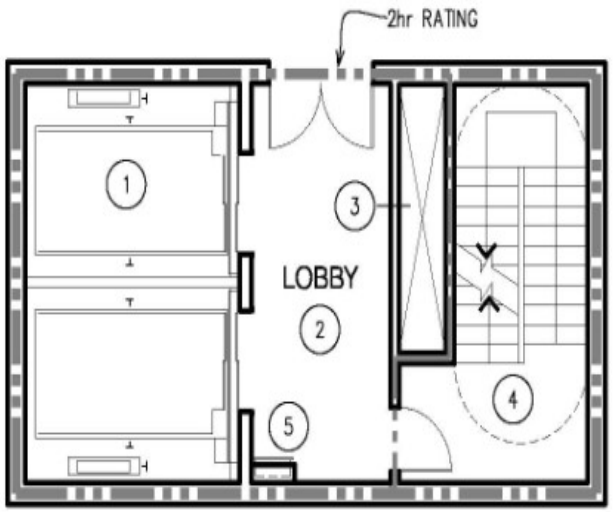
Design approaches







Standard elevator
1. Elevator car in standard hoistway
2. Unenclosed elevator lobby

Enhanced elevator
1. Hoistway improved with sensors, heat and water resistance of electrical components.
2. Lobby provided with smoke stop doors.

Protected elevator
1. Pressurized elevator car in a hoistway improved with sensors, heat and water resistant electrical components, pressurization and blast resistant walls.
2. Lobby provided with two-hour rated fire doors,
3. fire pressurization shaft and direct access to
4. emergency stairs within a separate fire and blast protected compartment.
5. Standpipe and hosracks would be in the lobby.