

# Fire protection of metro train for Copenhagen

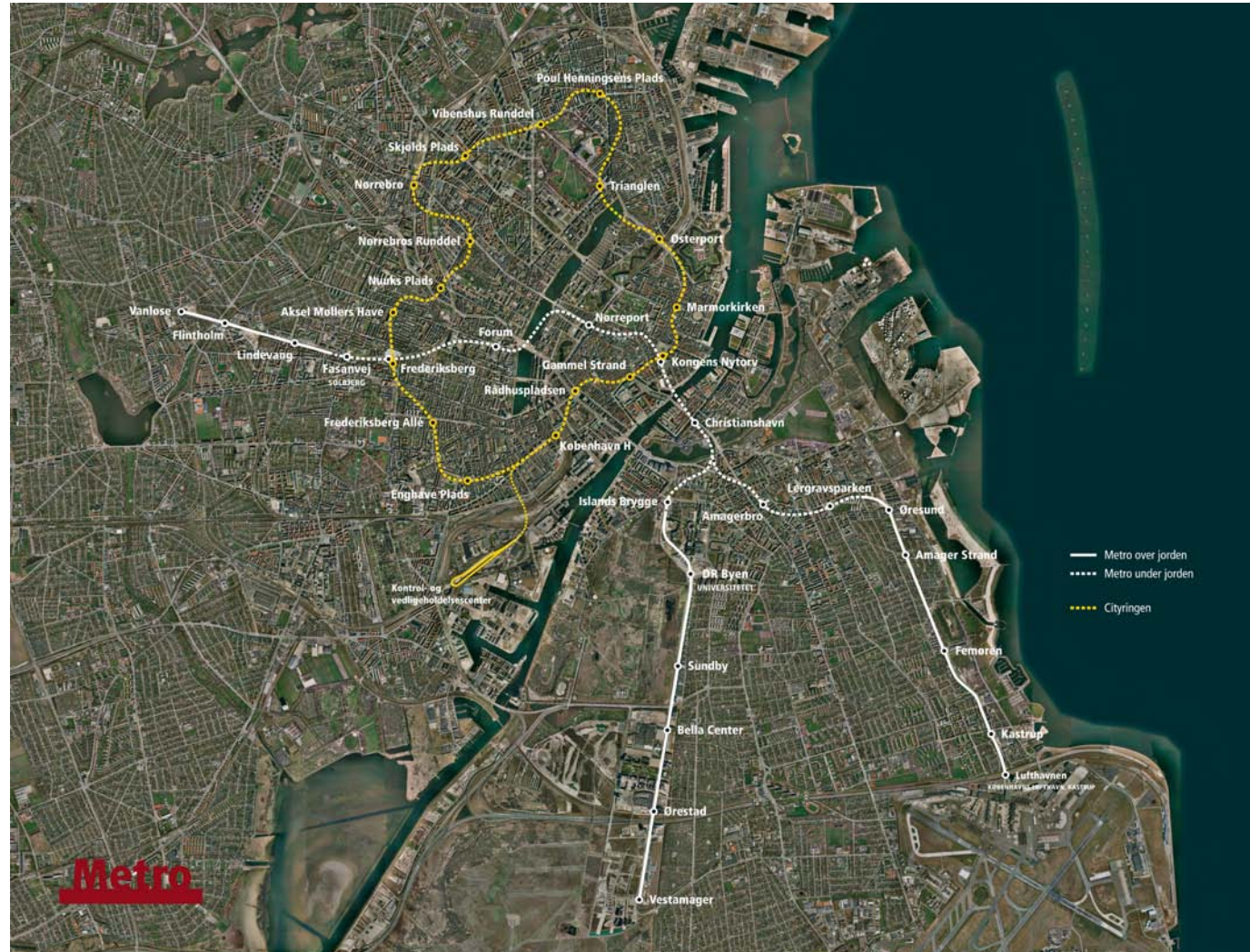
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# AGENDA 17. NOVEMBER 2010

- The Cityringen in Copenhagen
- The Rolling Stock
- Fire Protection on railway vehicles DS/CEN/TS 45545
- Fire simulation with ignition source (TS 45545 part 1)

# Cityringen - The alignment



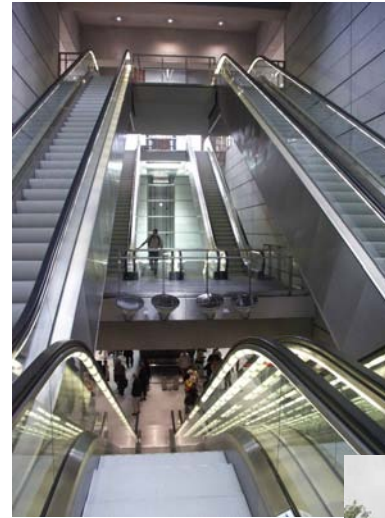


# Cityringen - The alignment



# The Owner and organisation

- Owners:
- Danish Government
- Municipalities of Copenhagen and Frederiksberg
- Client:
- Metroselskabet
- Civil works Consultant:
- JV between Cowi, Arup and Systra
- Transportation Consultant:
- JV between Rambøll and WS Atkins



# The Rolling Stock with focus on DS/CEN/TS 45545

- Key data of the train
- Fire Protection on railway vehicles CEN/TS 45545
- Alarm and communication systems
- Safety equipment
- Fire suppression
- Evacuation
- Fire and smoke development
- Access to the train





# The Rolling Stock, Key data

- Length 40 metre
- Height 3.40 metre
- Width 2.65 metre
- Speed 90 km/h
- Tare load 52 tons
- Bogie 3+1 Motor bogie and Trailer
- Doors 6 each side (5,5 metre distance)
- Floor height 0.810 meter nominal
- Capacity 302 – 314 passengers







# TS/DS 45545

Fire Protection on railway vehicles " DS" /CEN/TS 45545

- Part 1 General (Class, Ignition models)
- Part 2 Requirements for fire behaviour of material and components (Amount of materials, elements, test procedure)
- Part 3 Fire resistance requirements for fire barriers
- Part 4 Fire safety during design (minimizing risk of fire starting, evacuation)
- Part 5 Fire safety for electrical equipment
- Part 6 Fire control and management systems (detecting, alarms, communication, PA , emergency light, emergency brake, fire fighting equipment, pictograms etc.)

# The Rolling Stock, TS45545 Part 1 General (Class, Ignition models)

## Annex A (informative)

### Ignition models within the scope of the Technical Specification

- 1) Flaming source is 3 min duration and average power output of 7 kW generating a flux of 25 kW/m<sup>2</sup> to 30 kW/m<sup>2</sup>.
- 2) A radiant flux of nominal value 25 kWm<sup>-2</sup> applied to an area of 0,1 m<sup>2</sup>.
- 3) A radiant flux of nominal value 50 kWm<sup>-2</sup> applied to an area of 0,1 m<sup>2</sup>.
- 4) Flaming source of power 1 kW and 30 s duration.
- 5) A flaming source generating a radiant flux of nominal value in the range 20 kWm<sup>-2</sup> to 25 kWm<sup>-2</sup> applied to an area of 0,7 m<sup>2</sup> with an average heat of 75 kW for a period of 2 min followed immediately by a flux of nominal value in the range 40 kWm<sup>-2</sup> to 50 kWm<sup>-2</sup> applied to the same 0,7 m<sup>2</sup> area with an average heat of 150 kW for a period of 8 min.

These ignition models are used to achieve the objective written in 4.2, 4.3 and 4.4.

EXAMPLE The combustion of a 100 g UIC 564-2 – paper cushion (newspapers) is of equivalent effect to ignition model 1.

# The Rolling Stock , TS45545 part 4 design, escape route, access

- The vehicle will have 6 doors each side (as primary escape route)
- All doors will be equipped with mechanical emergency door opening devices
- Emergency hammer (only for side windows not for windscreen)





# The Rolling Stock , TS45545 part 4 Escape route and equipment

- All doors will be equipped with an emergency door opening handle outside
- All doors will have an external access step for easy access to the train
- PA direct from control centre to the train
- All high power installation is located under the floor

## The Rolling Stock, Movement of failed train, part 4

- The train will be equipped with automatic couplers
- The system will support automatic rescue operation in driverless operation
- Train can be rescued by a service vehicle

# The Rolling Stock

TS45545 Part 6 Fire control and management systems (detecting, alarms, communication, PA emergency light, ventilation etc)

- Smoke detection and heat detection
- Alarm and communication point in each vestibule

Alarm ->



online CCTV ->

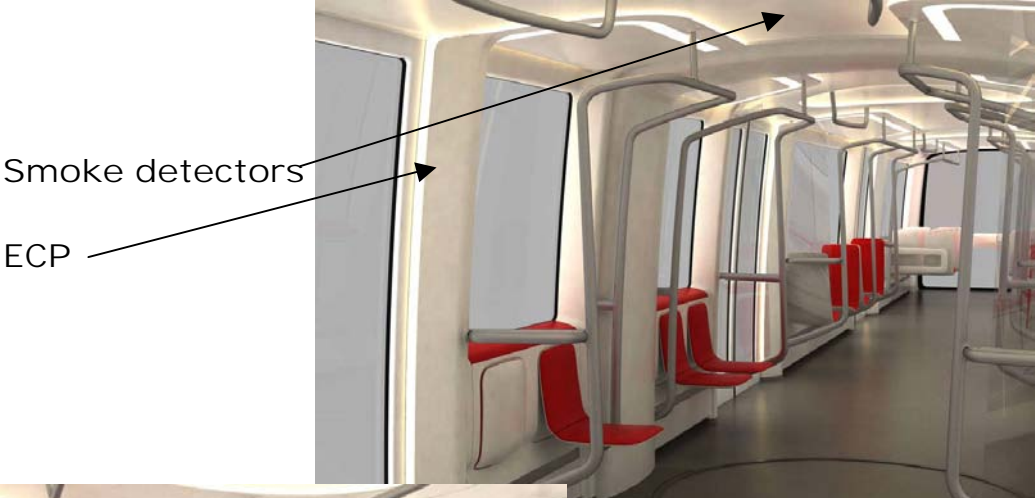


full duplex line from ECP

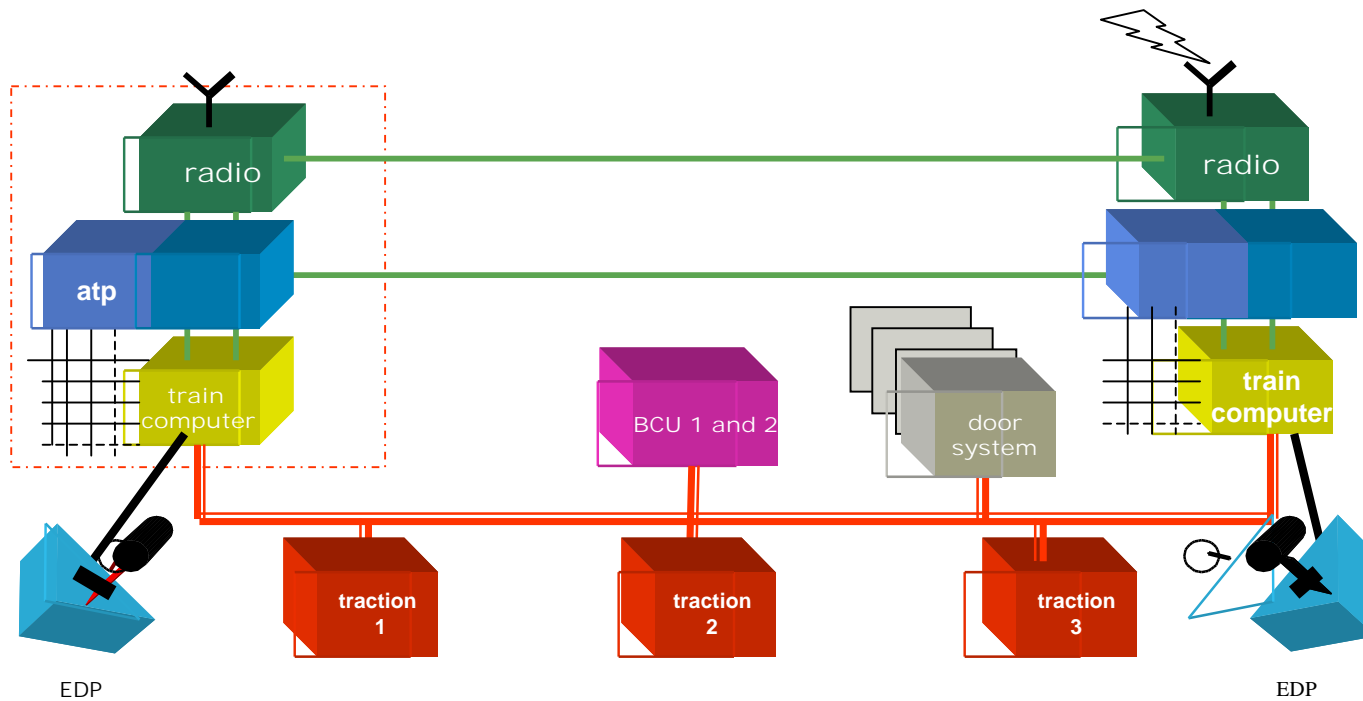




# The Rolling Stock, Alarm and Communication in the passenger area

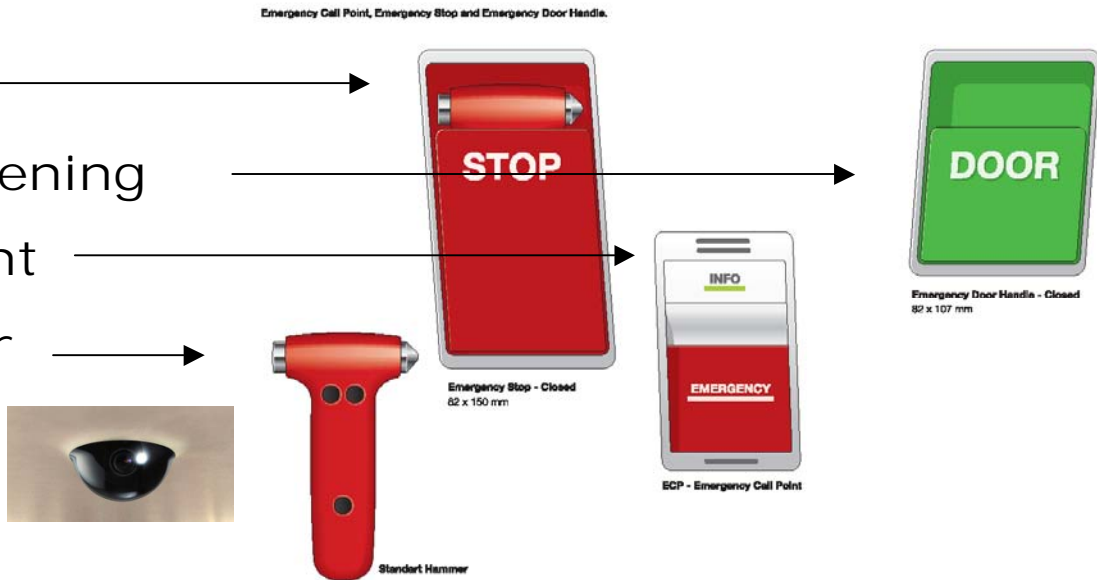


# The Rolling Stock, TS 45545 part 6 Alarm and detection from M and E equipment



# The Rolling Stock, En45545 part 6 Safety equipment

- Emergency brake
- Emergency door opening
- Emergency call point
- Emergency hammer
- Fire extinguisher
- CCTV
- Emergency ventilation
- Manual control of train
- External CCTV in front





# The Rolling Stock, Fire suppression system (part 6)

## New features of rolling stock

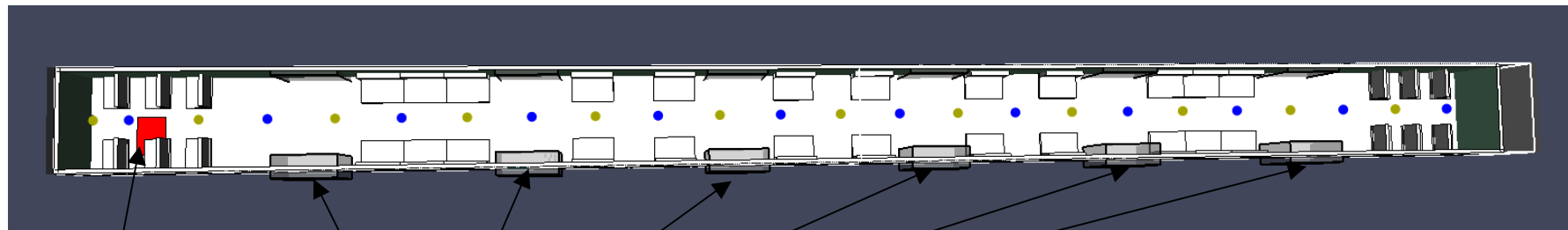
- Early warning smoke detection system
- New standard on "Fire Protection"
- Fire suppression system
- Online CCTV surveillance
- Updated event recorder
- Traction on all bogies (maybe)
- Access step at all doors from outside
- Access to train by all doors from outside
- .....

# Fire simulation inside the train

Using flame spreading models, and sprinkler activation



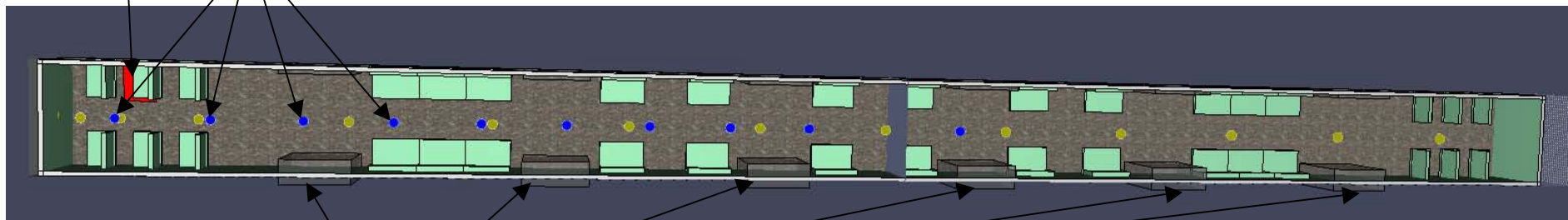
# Geometrical model of a metro train and fire location



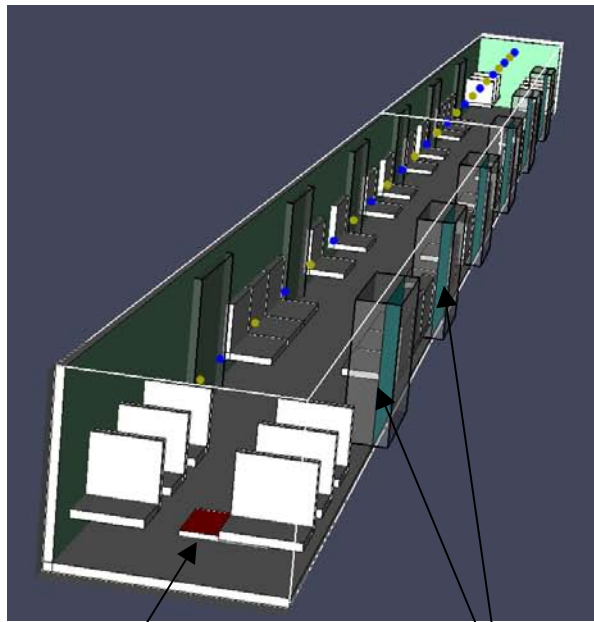
fire source

doors

sprinklers

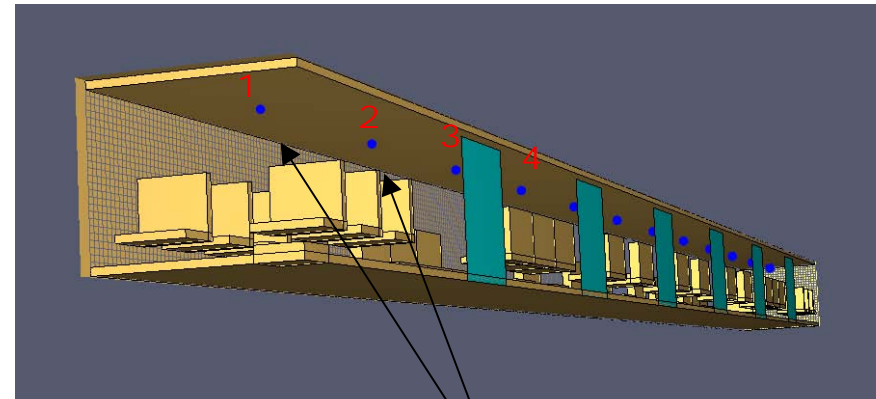


# Location of fire source – in centre gangway or under the seat

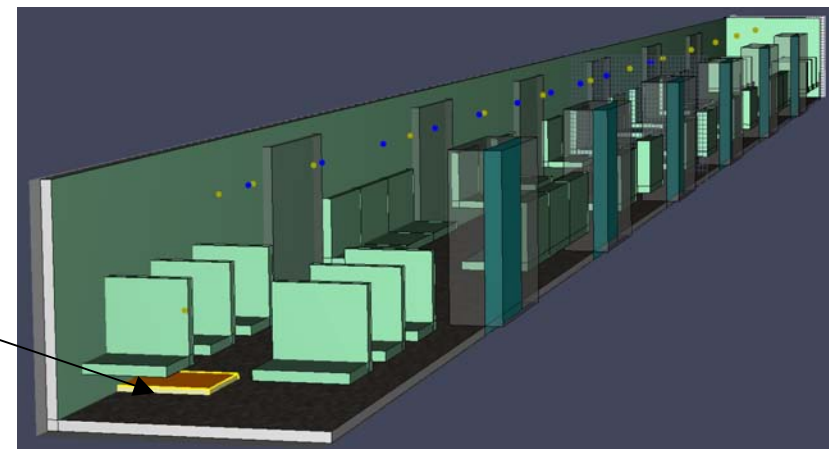


Fire source

doors



sprinklers

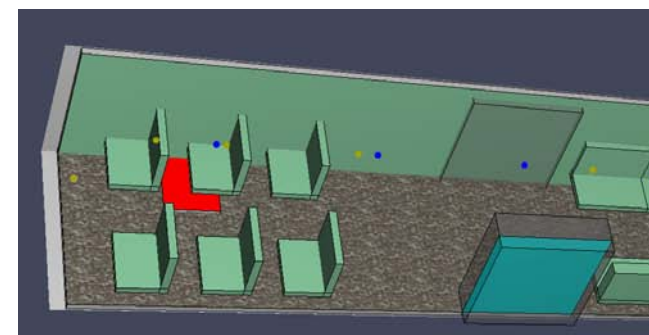
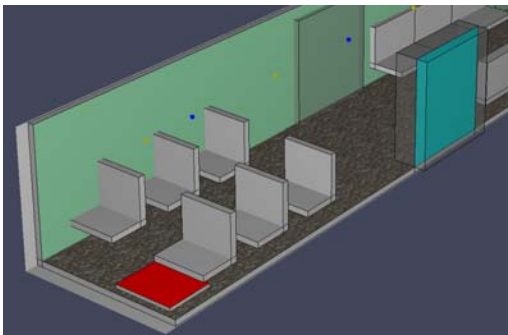


## Ignition source – chosen from Standard

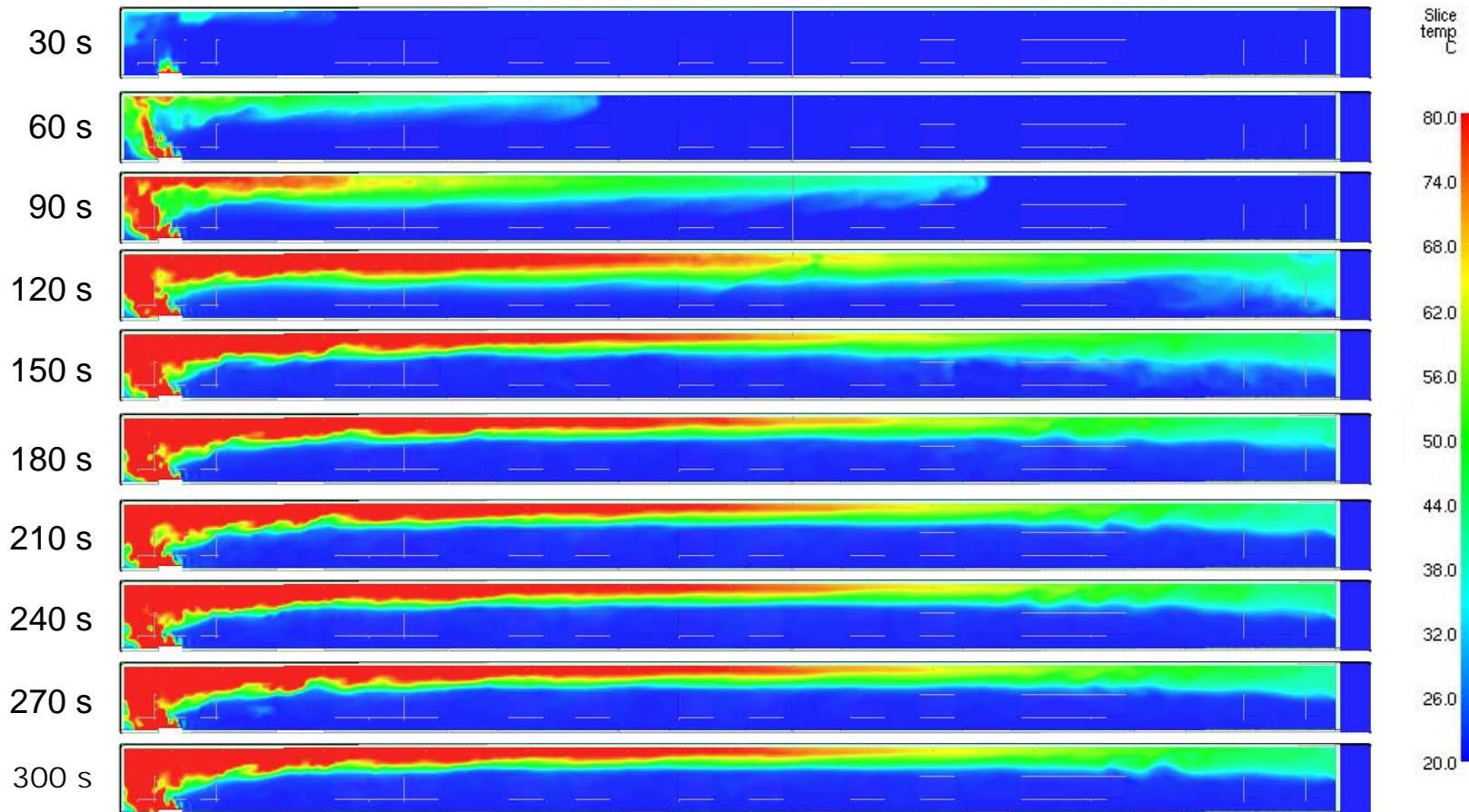
- This ignition model is based on ignition model 5 in ref /1/. The average heat release rate is 75 kW in the first two minutes of the fire, followed by 8 minutes with an average heat release rate of 150 kW.

## Determining the temperature level from the baseline fire/ignition fire scenarios. (No sprinkling inside)

- Wall surface temperature for 3 different locations of the fire:
  - *Close to the end wall (corner)*
  - *In the centre of the gangway*
  - *Close to the side wall, under the seats*



# Temperature down the middle of the train No wind in tunnel and no sprinkler



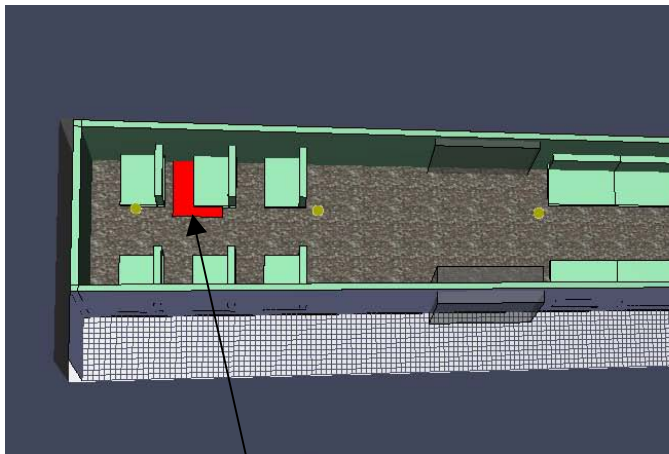


## With sprinklers

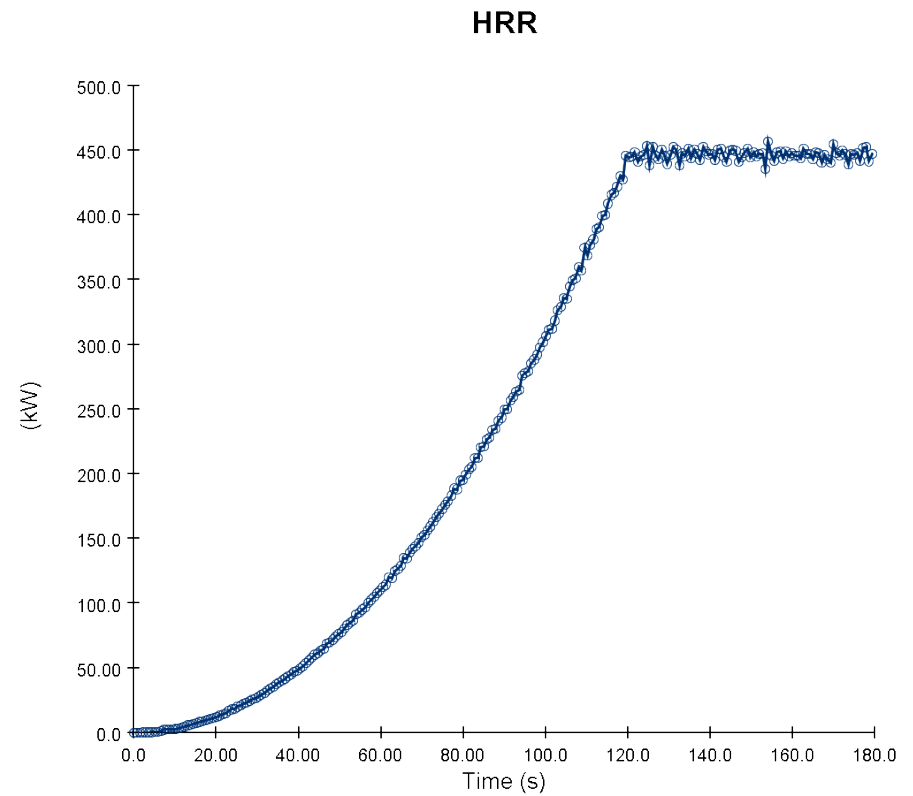
- The sprinklers are setup as follows:
  - RTI: 100 (starting point)
  - Activation temperature: 74 C
  - Water: 30 l/min per sprinkler
  - Spray angle: 45 degree (should be evaluated close to design specification)
  - Spray velocity: 5 m/s (should be evaluated close to design specification)
  - Sprinkler distance in model: 2 metres. However can be increased up to 3 metres, if the sprinkler coverage area is better (spray angle and velocity should be different)

# Large fire: ~0.5 MW fire close to the side wall

Fire curve

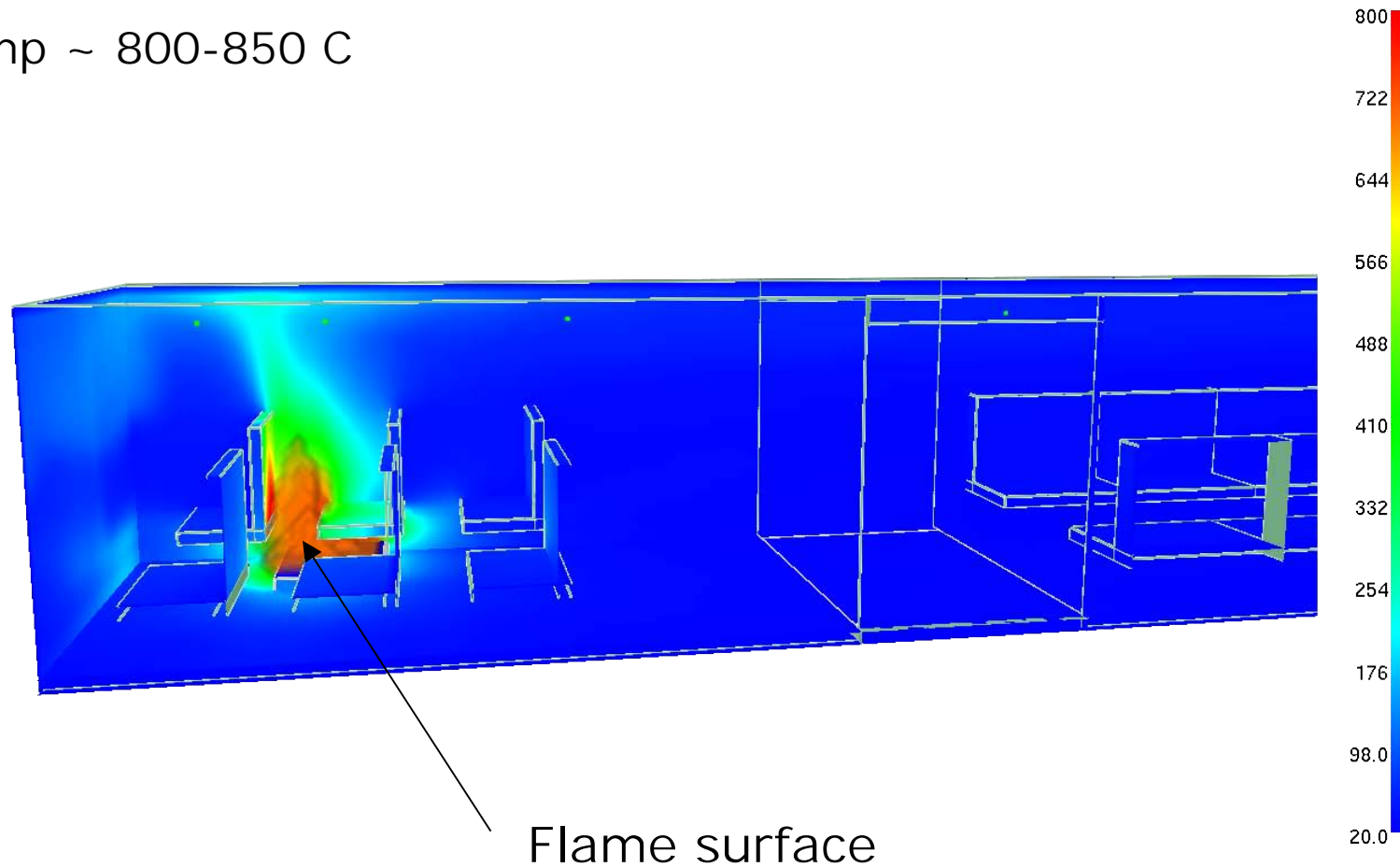


Fire location



Large fire: ~0.5 MW fire close to the side wall  
Wall surface temperature:  
Close to the side wall/under the seat after 120s

- Max temp ~ 800-850 C



# Materials; Sprinkler

- Evaluation
- Using a sprinkler with a good coverage will ensure that a fire will not spread and turn into a flash over event. The sprinkler can suppress a fire in relative short time dependent on the location inside the train. The suppression occurs during 1 – 2 min.
- A large scale fire event with a peak heat load of 0.5 MW inside the train (located close to a wall and under a seat) will produce a critical fire if no suppression is applied. Sprinkler will be able to suppress the fire in the early stages.