

Tunnel ventilation design

Quantitative methods for
comparative analyses

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When this approach can be used

- **At Pre-design and Design stages:**

Alternative solutions are examined at feasibility or design stage.

Consequences weight is evaluated comparing different configurations under the same hypothesis.

- **During the lifecycle of the Infrastructure (Management stage):**

When an update normative context obliges modifications in existing operas,

impact could be measured through quantitative methods.

Fire Engineering as intersections of other disciplines

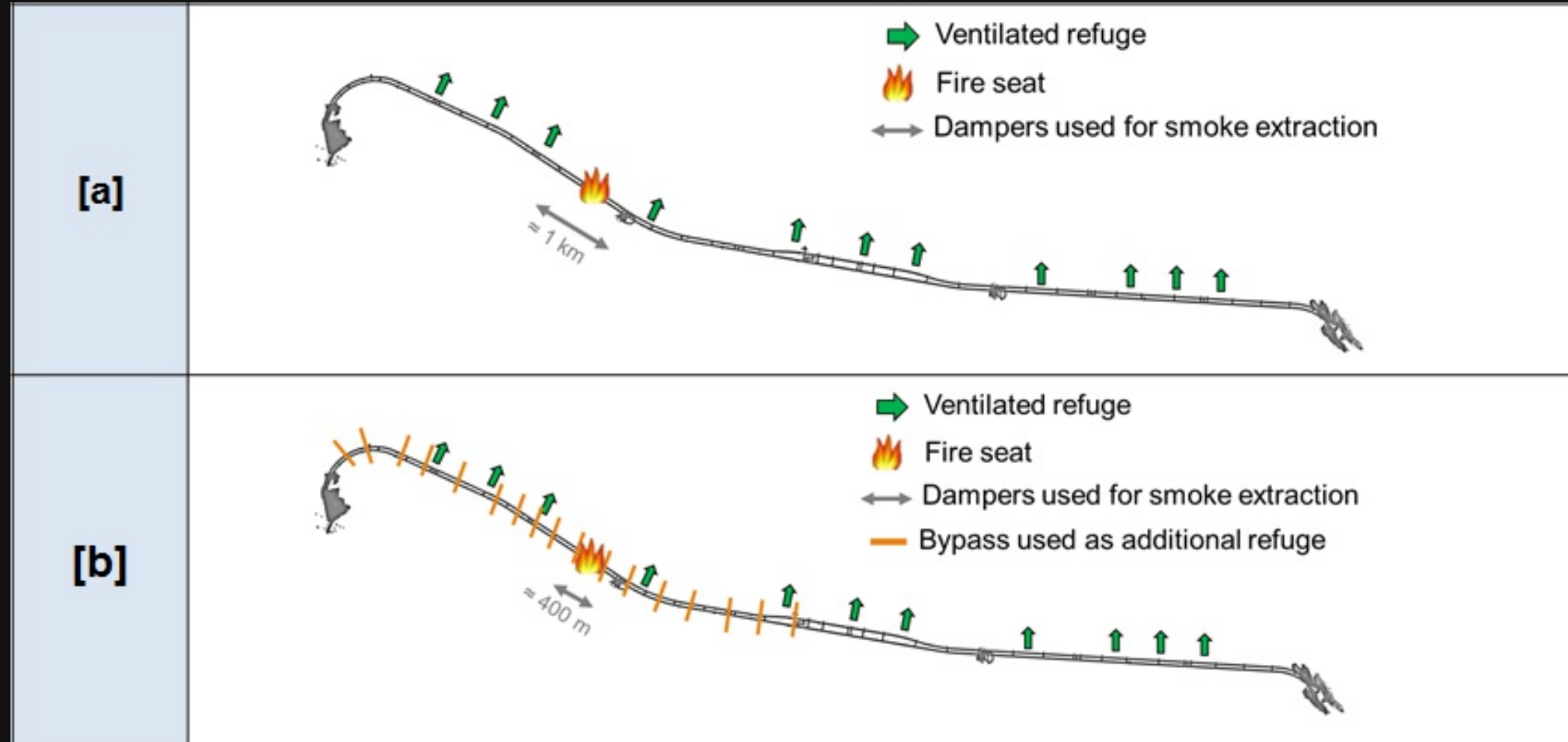
- Architectural
- Civil Works
- Mechanical Ventilation

Methodology

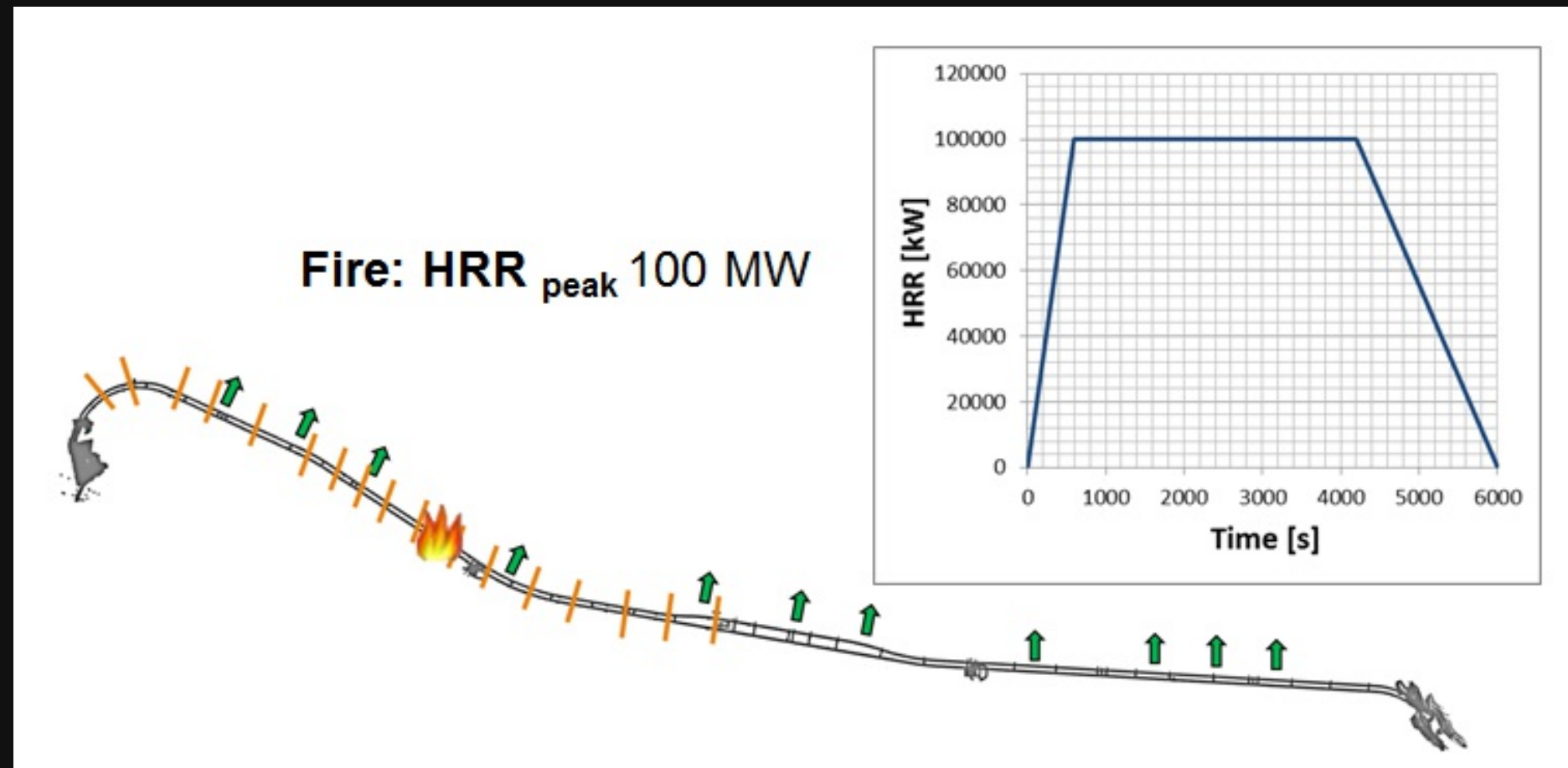
Through a multiscale approach combining 1D and CFD + evacuation analyses, it is possible to evaluate the interaction between people and combustion products.

CASE 1

- two ways tunnel
- transversal ventilation logic
- evacuation system is provided of ventilated refuges



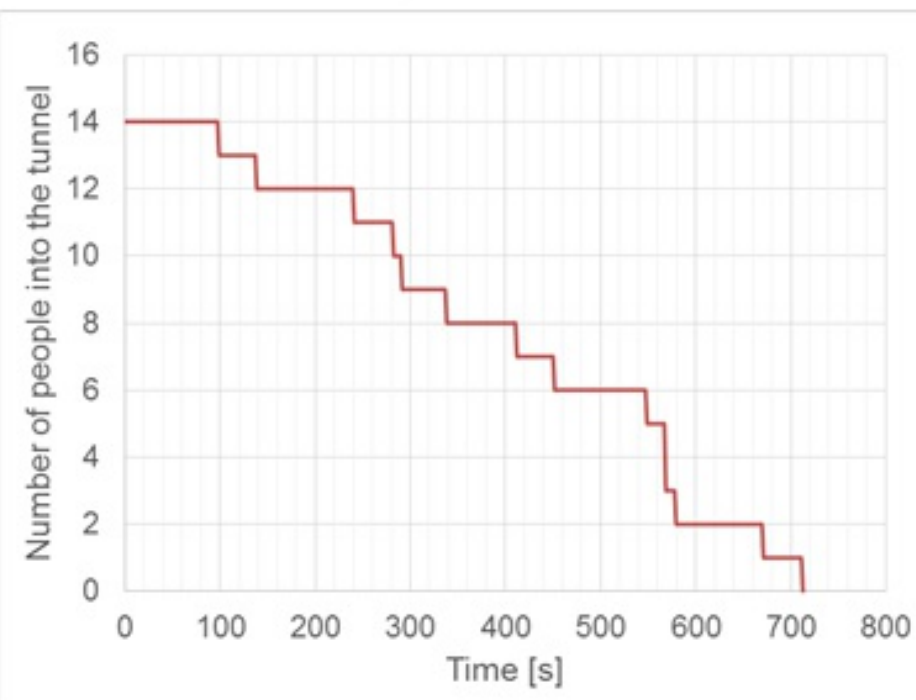
CASE 1 - Fire Scenario Hypothesis



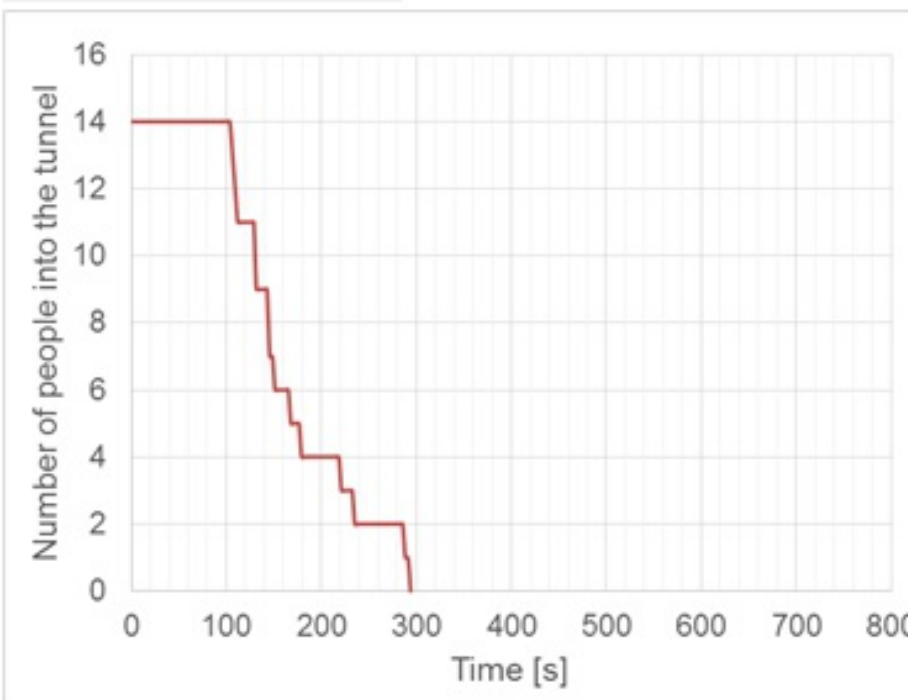
CASE 1 - Evacuation results

	[a]	[b]
Number of occupants	22	22
Egress time	837 s	294 s
FED max	2.8E-02	0.0E+00

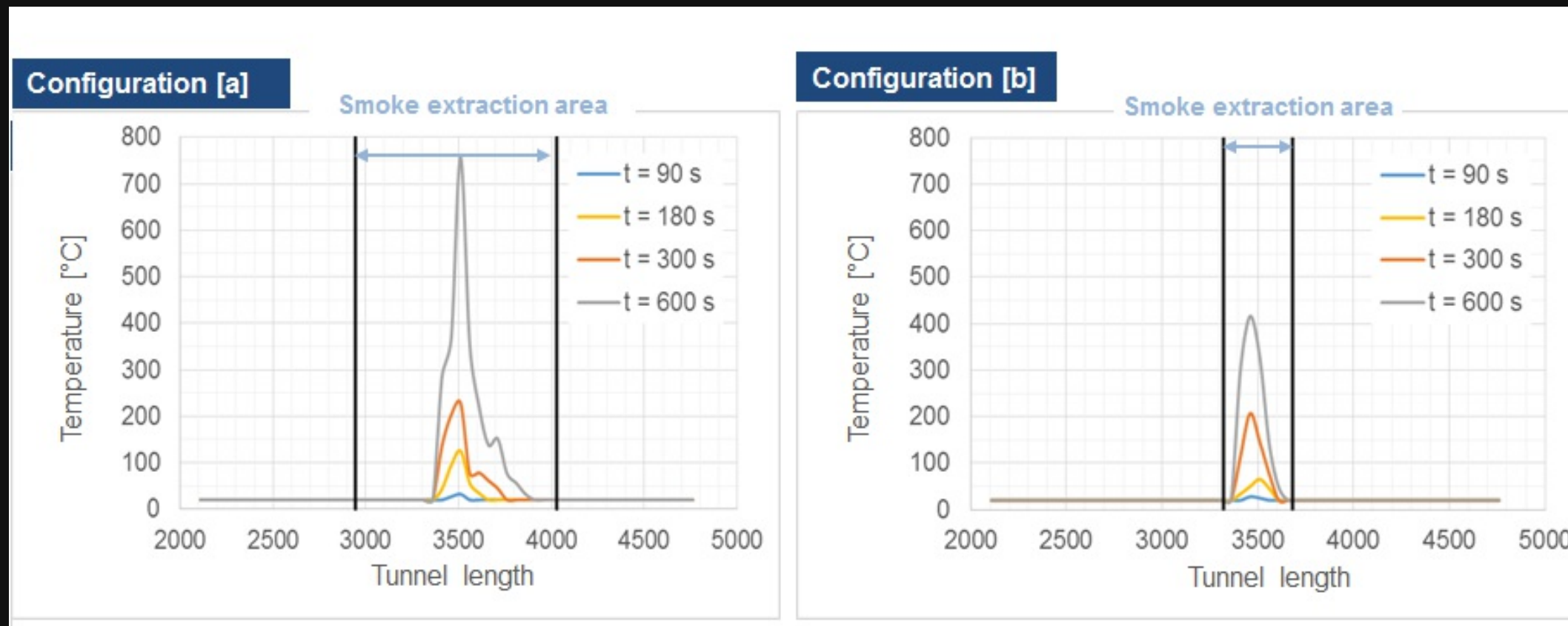
Configuration [a]



Configuration [b]



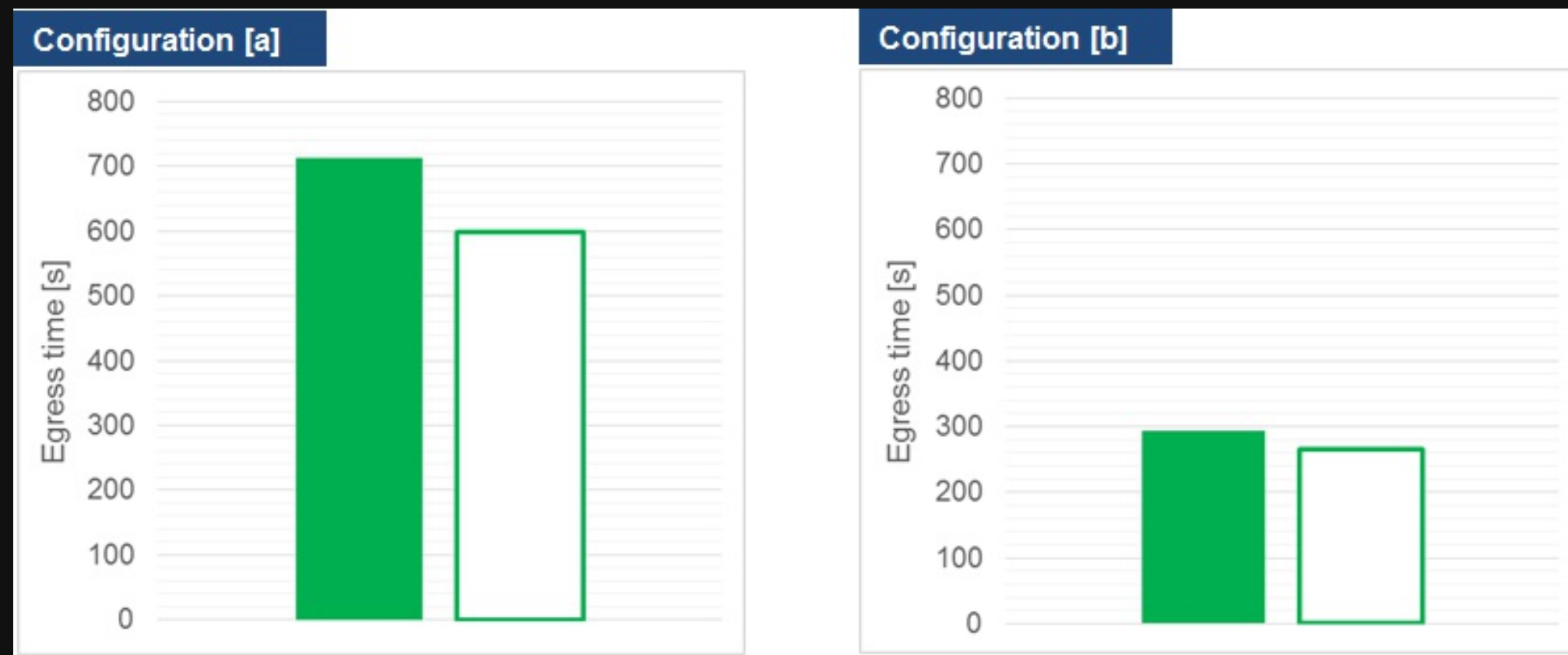
CASE 1 - Smoke control results



CASE 1 - Comparative analysis

Empty columns correspond to egress evaluated in no fire case (fire drill).

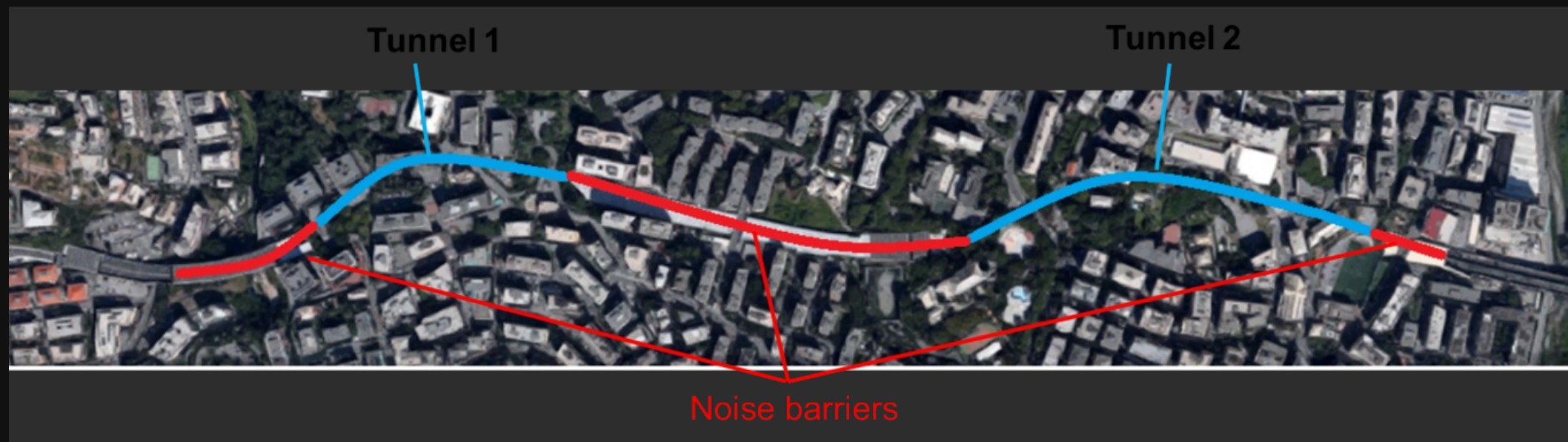
The comparison gives an estimation of how much the configuration_b is close to a not emergency situation.



CASE 2

Existing opera - Impact of a noise barrier installation between two existing tunnels

- a) current configuration (tunnels are fluid dynamically independent)
- b) a noise barrier connect the tunnels and makes them a unique longer tunnel



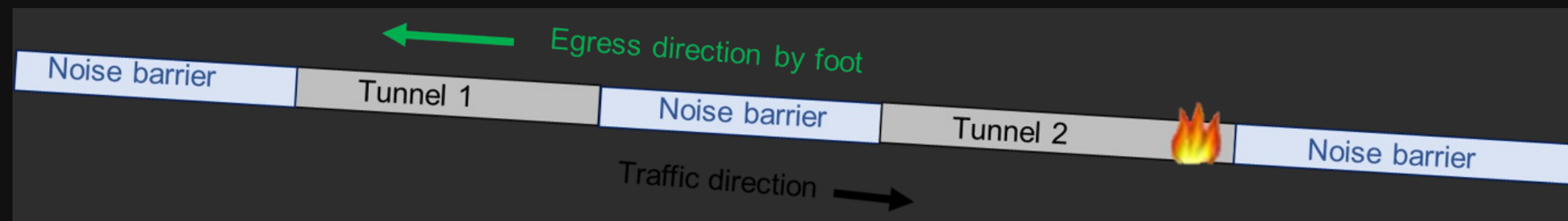
CASE 2 - Tunnel characteristics

- 2 one-way tunnels
- no ventilation
- no bypass and no refuges



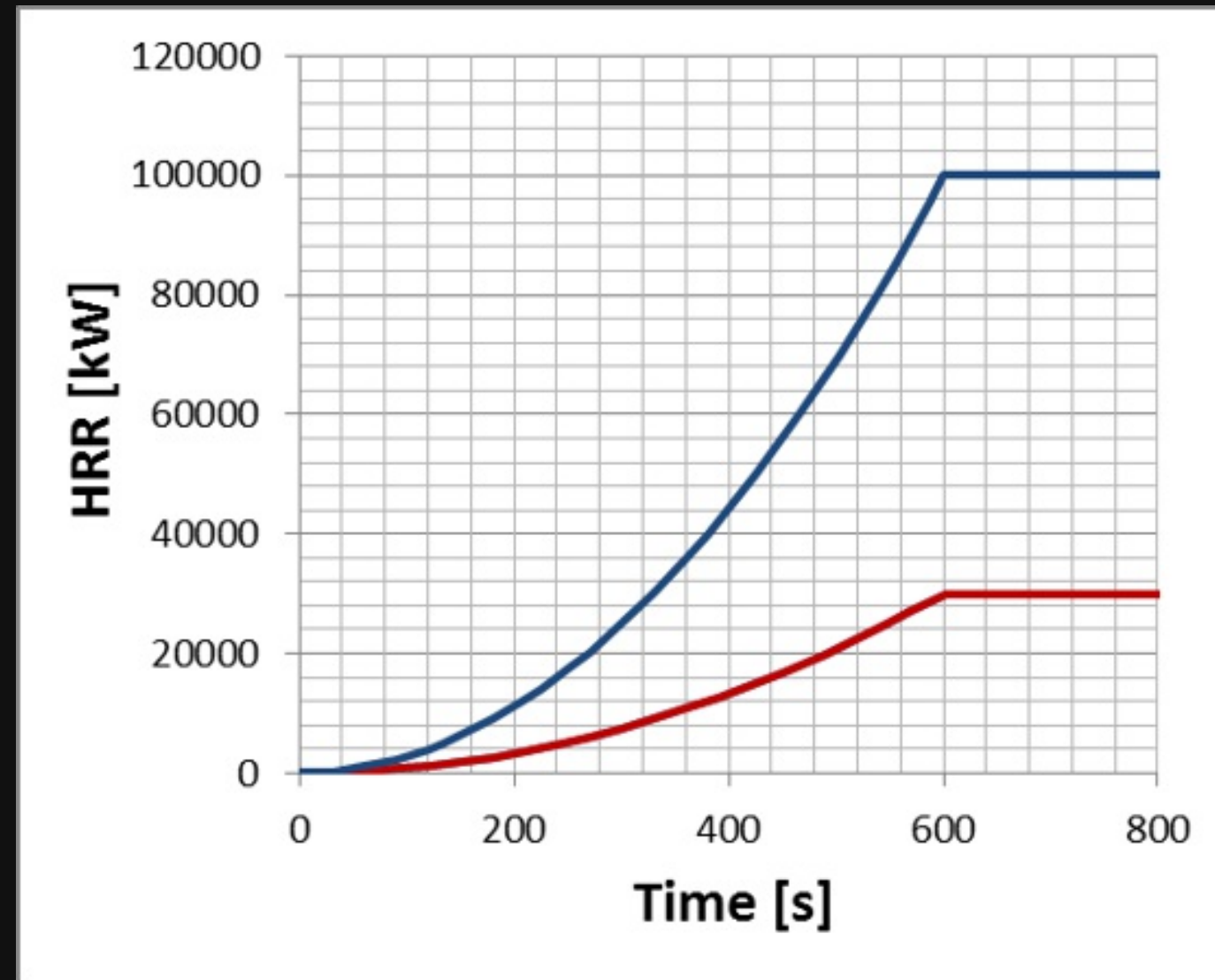
CASE 2 - Fire Scenario

Fire: positioned at the lowest point of the tunnel (worst case)



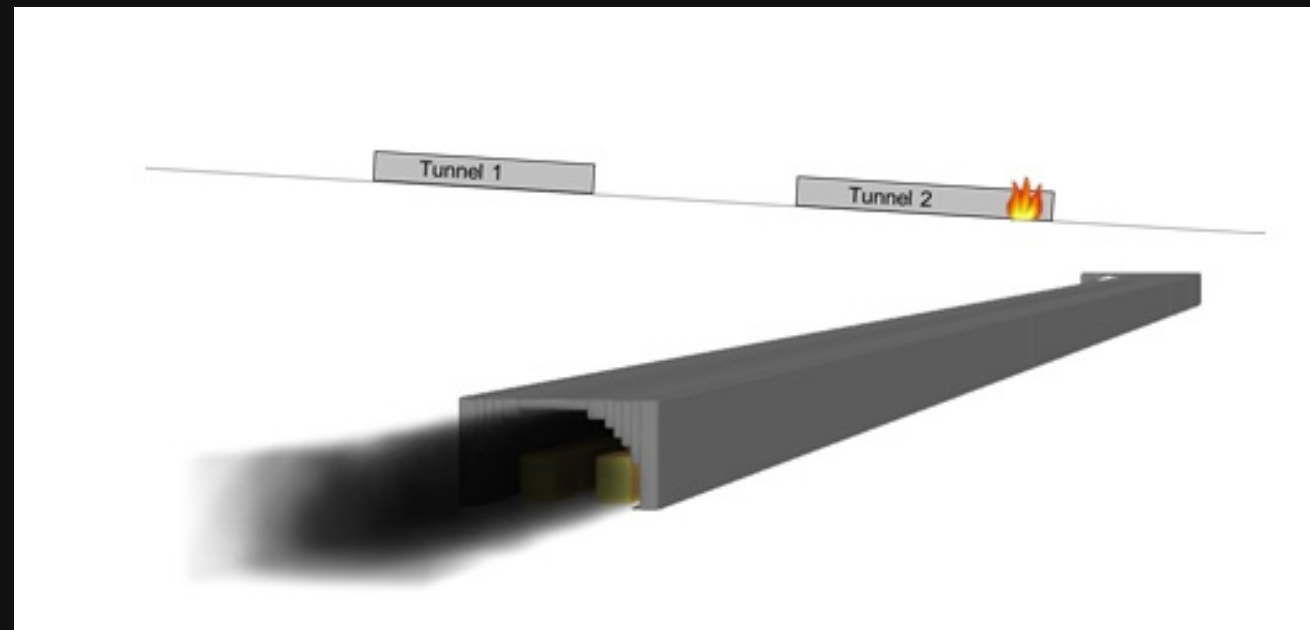
CASE 2 - HRR curve

2 HRR are considered (30 and 100 MW)



CASE 2 - Results - smoke control

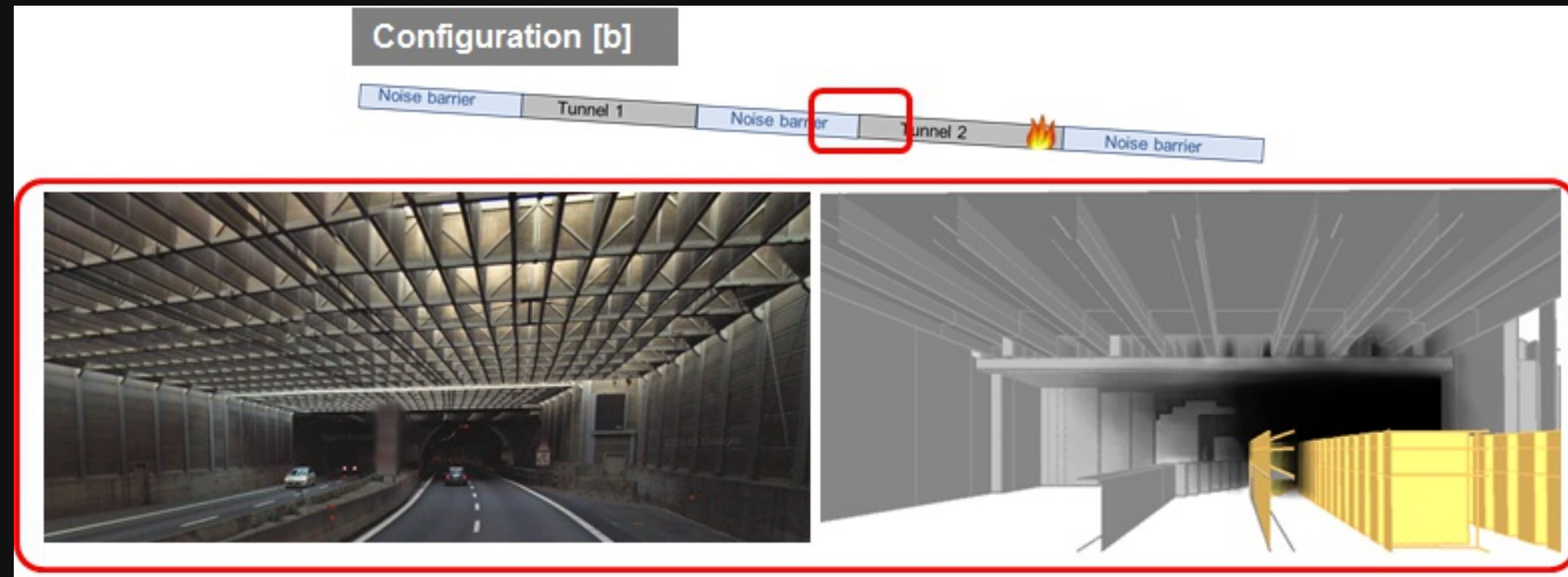
Configuration_a



Without the noise barrier, smoke exits from right tube of tunnel 2 and spread in the environment without involving tunnel 1.

CASE 2 - Results - smoke control

Configuration_b

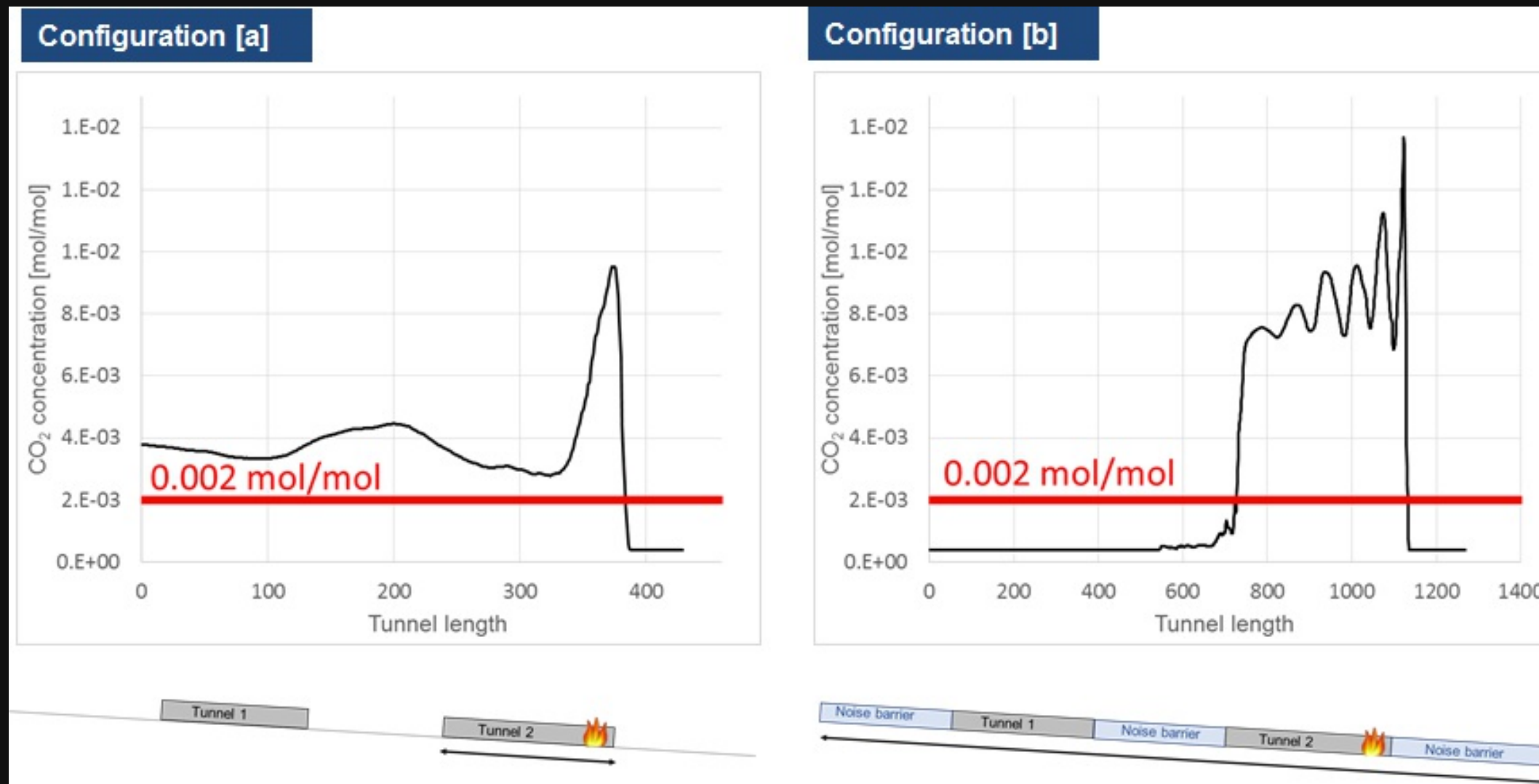


After 240 s from ignition, smoke exits from the right tube of tunnel 2 and moves along the noise barrier.

At 750 s, smokes enters both the tubes of tunnel 1.

CASE 2 - Results - CO concentration

CO concentration is higher in presence of the noise barrier.



Conclusions / 1

In road tunnels, when the interaction between occupants and combustion products is not negligible egress can not be calculated under the hypothesis of 'occupant never interact with combustion products'.

FED analysis is necessary.



Conclusions / 2

A suggestions for Thunderhead Engineering: Pathfinder could take into account:

The reduction of the occupant speed based on low visibility;

the contribution of the thermal FED in addition to the toxic FED.



Thanks for your attention