

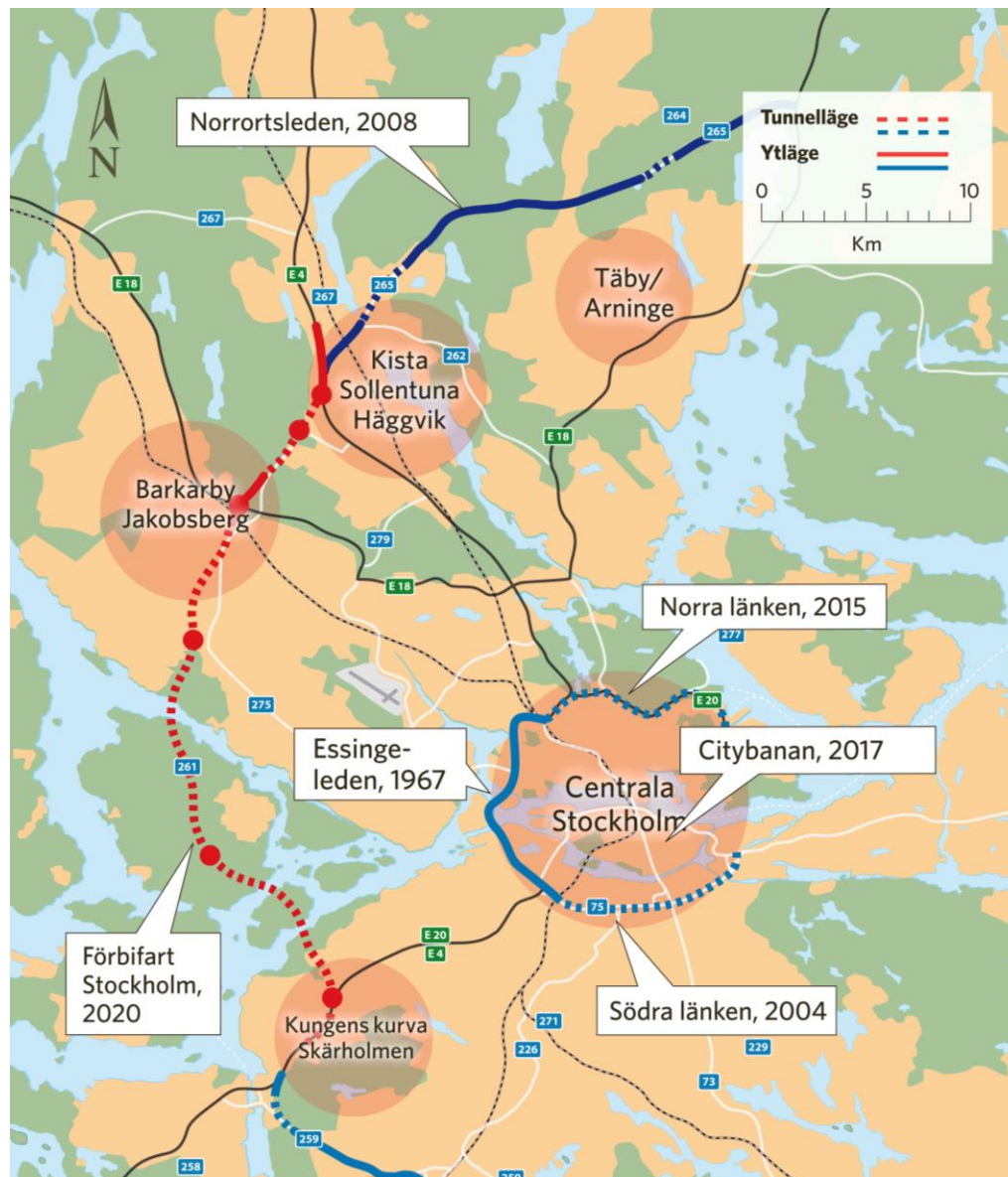
Operational Needs leading to Safety Research Developments

Ulf Lundström
Safety officer Swedish
Transport Administration



TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION







Safety concept at the Millenium: Southern Link 2004

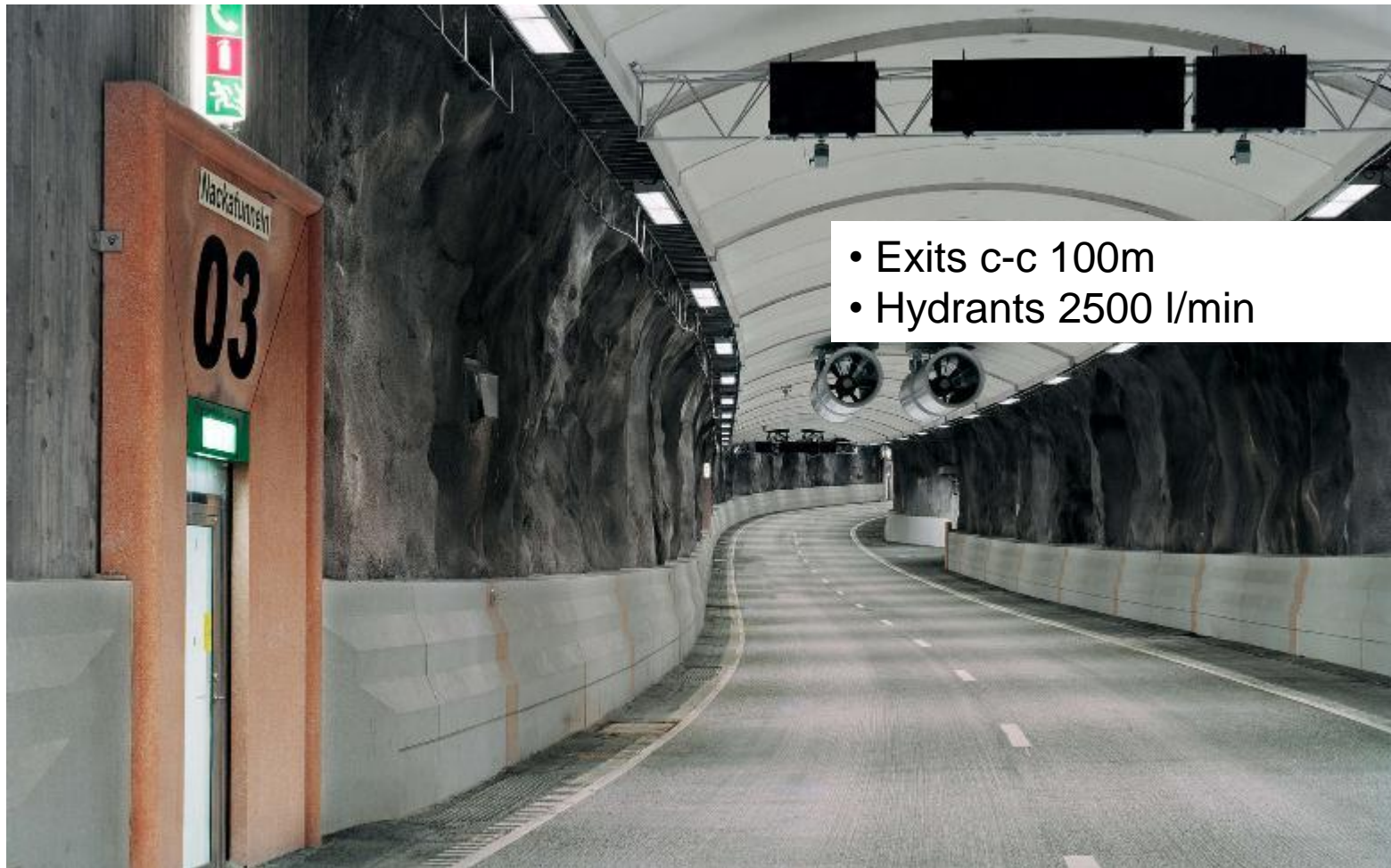


Safety concept at the Millenium: Southern Link 2004

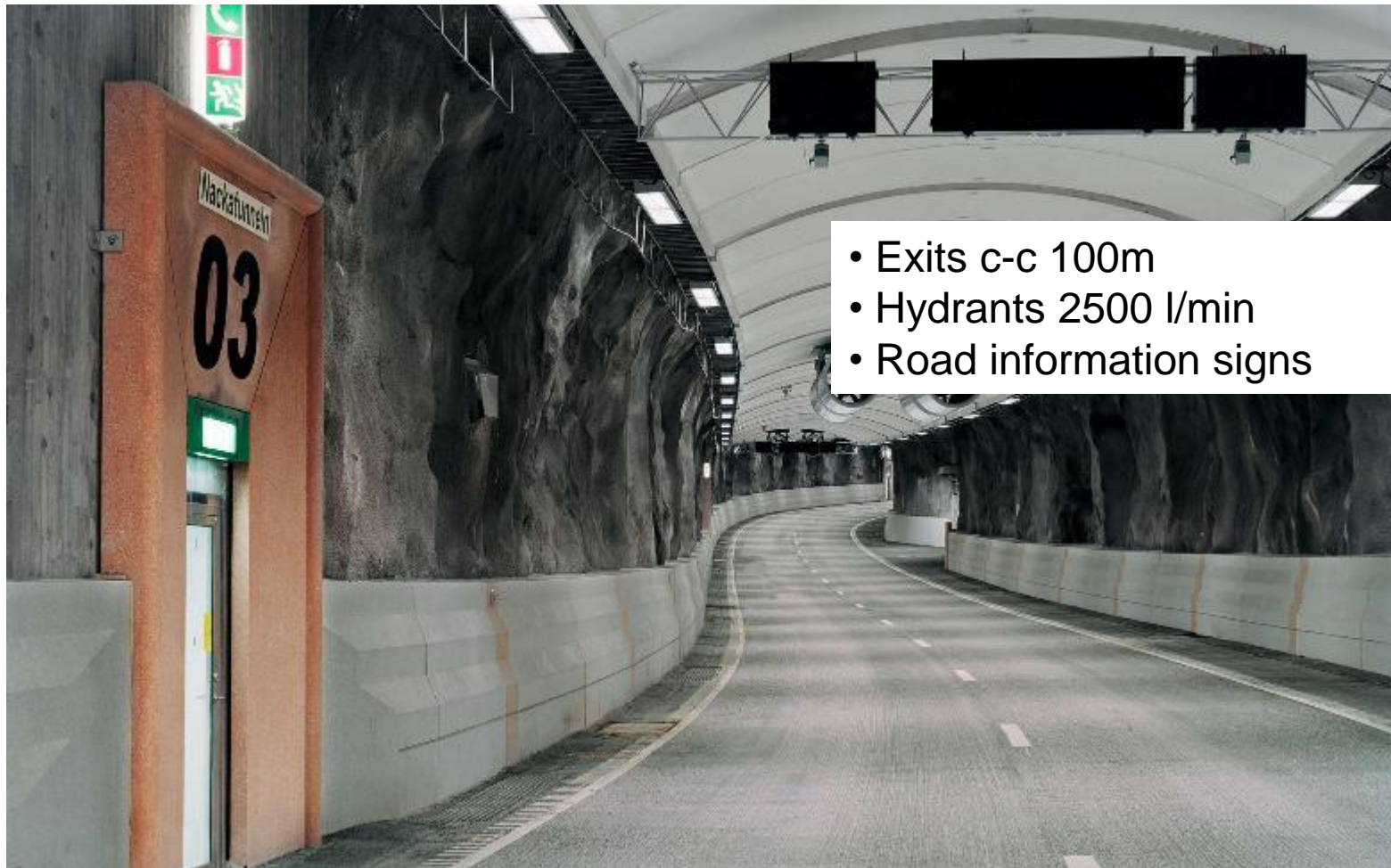


- Exits c-c 100m

Safety concept at the Millenium: Southern Link 2004

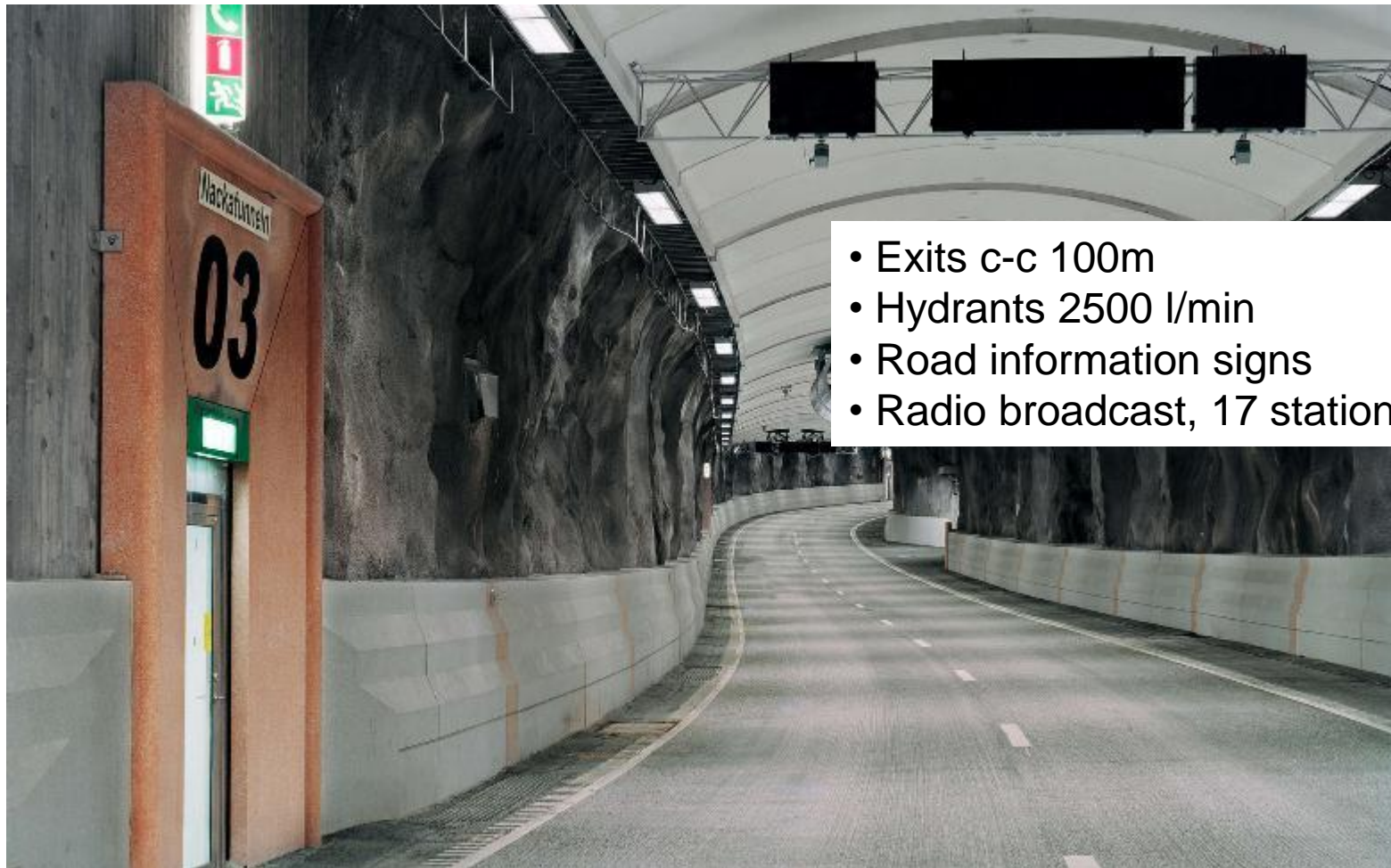


Safety concept at the Millenium: Southern Link 2004



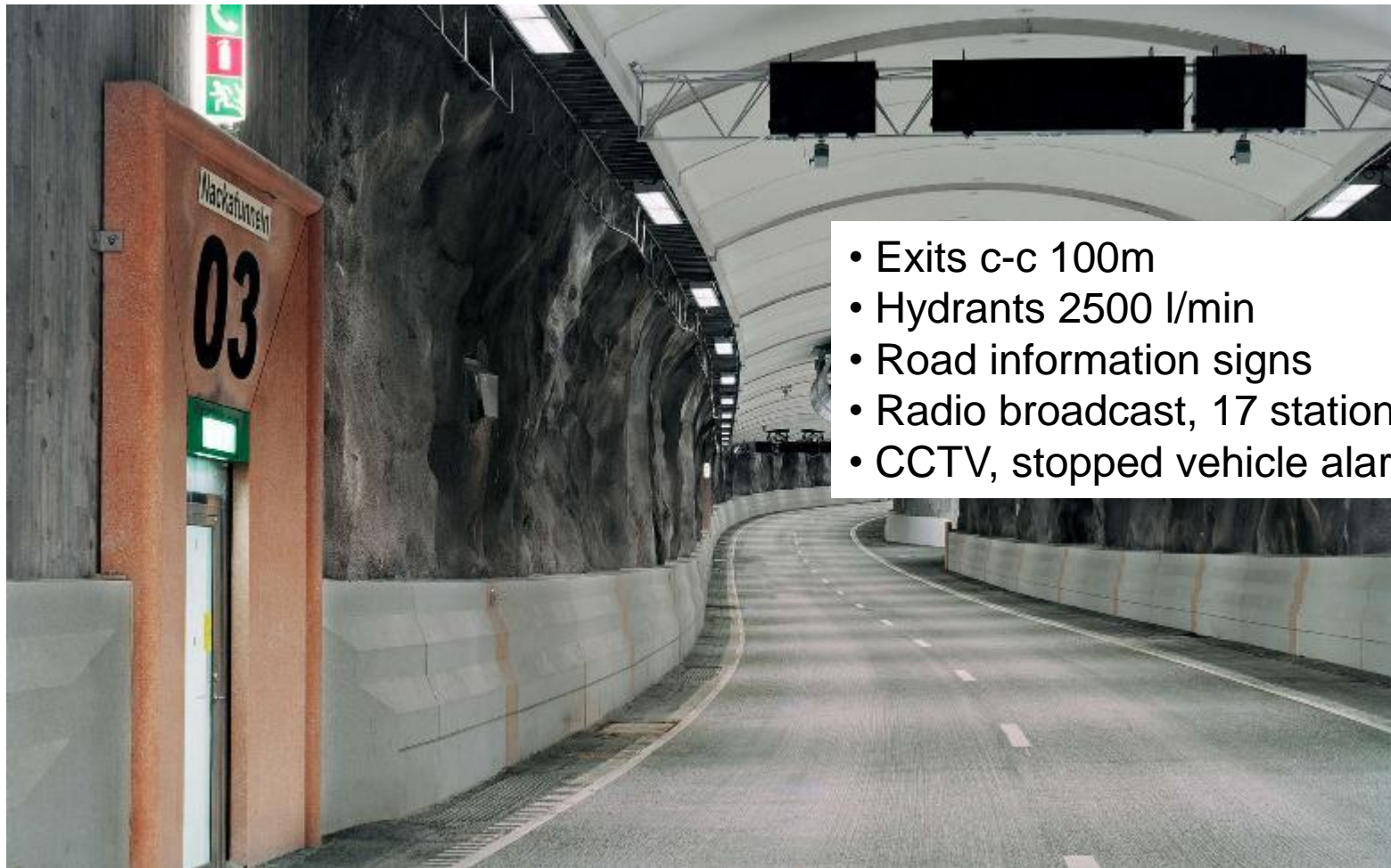
- Exits c-c 100m
- Hydrants 2500 l/min
- Road information signs

Safety concept at the Millenium: Southern Link 2004



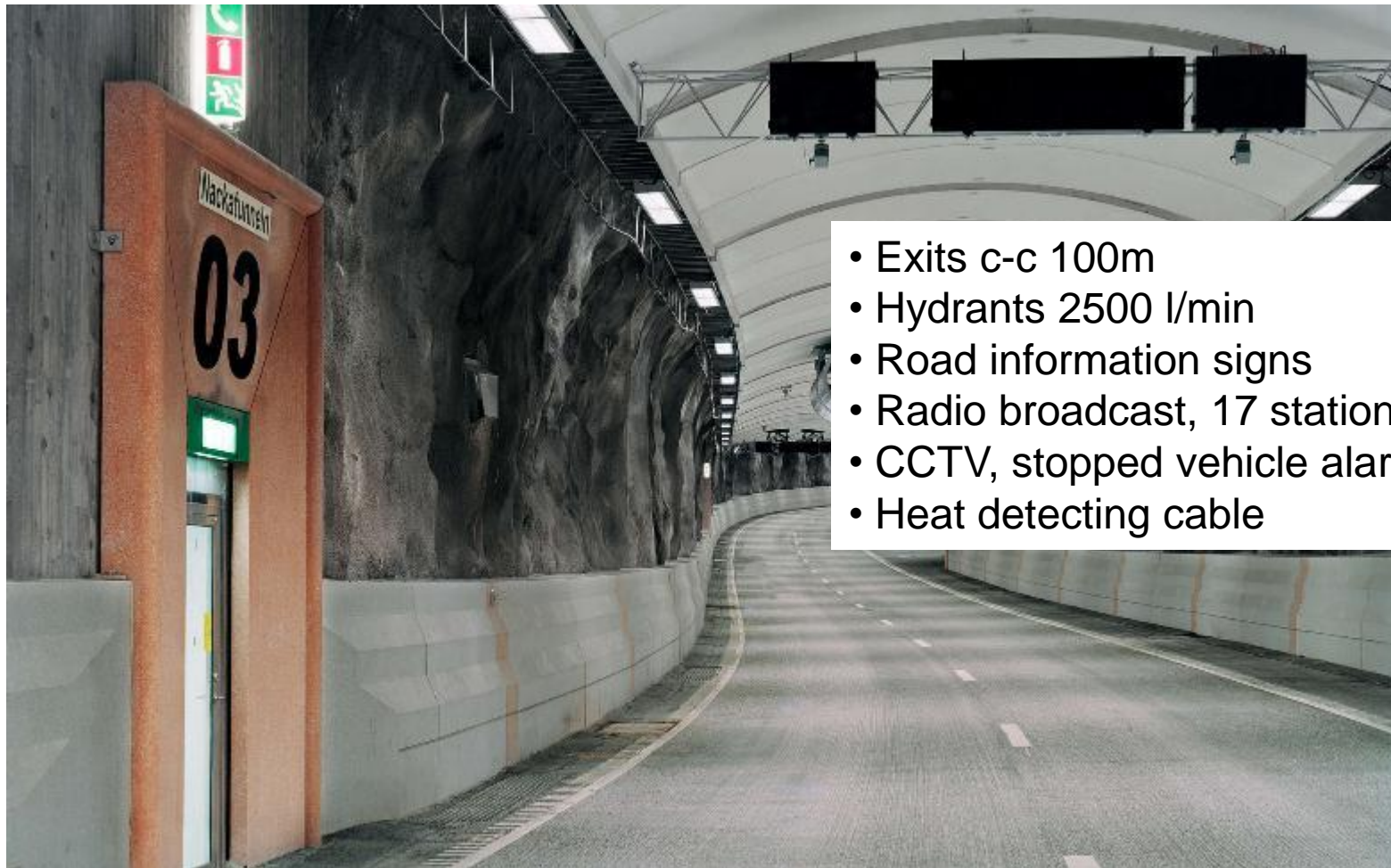
- Exits c-c 100m
- Hydrants 2500 l/min
- Road information signs
- Radio broadcast, 17 stations

Safety concept at the Millenium: Southern Link 2004



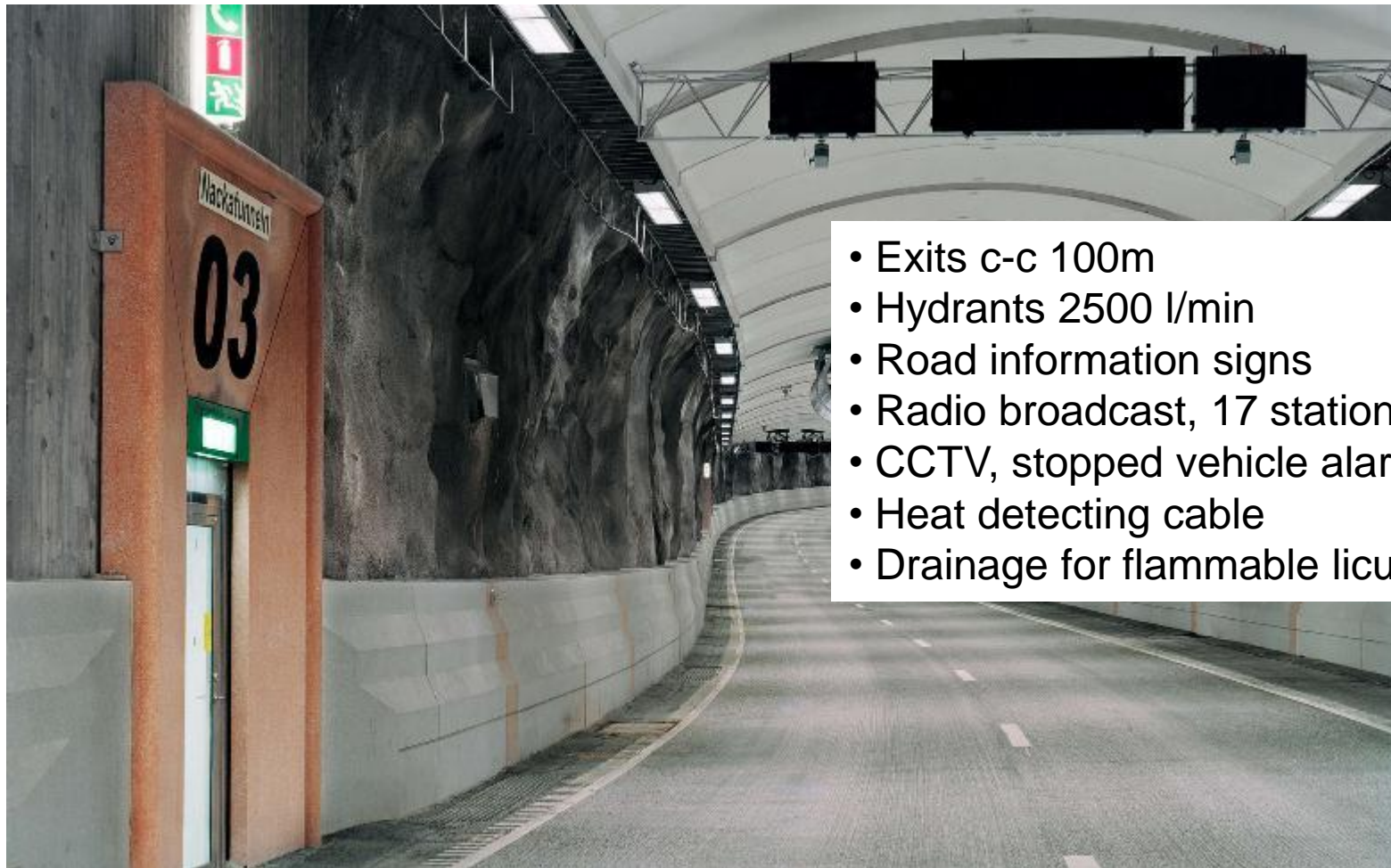
- Exits c-c 100m
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- Radio broadcast, 17 stations
- CCTV, stopped vehicle alarm

Safety concept at the Millenium: Southern Link 2004



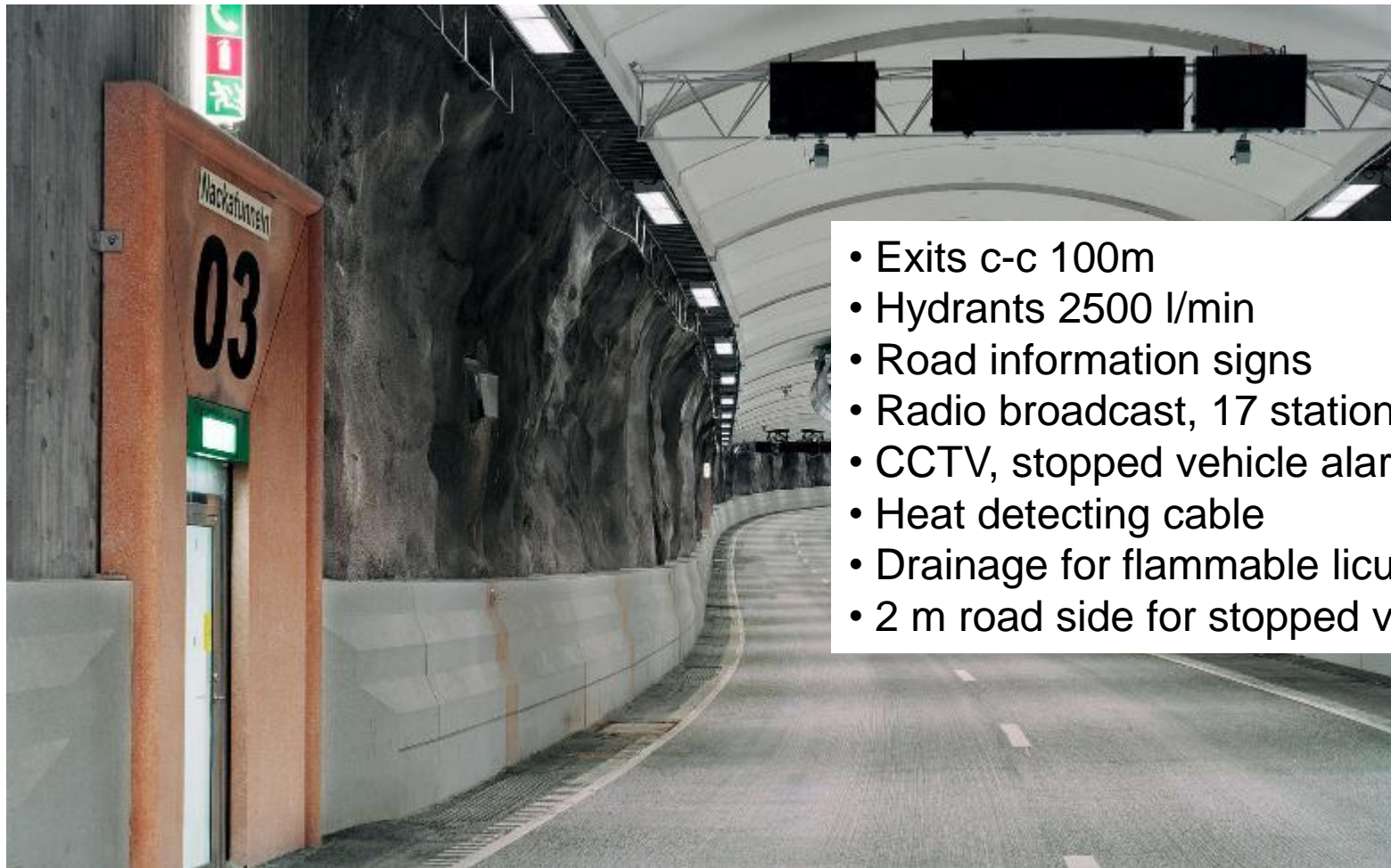
- Exits c-c 100m
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- Heat detecting cable

Safety concept at the Millenium: Southern Link 2004



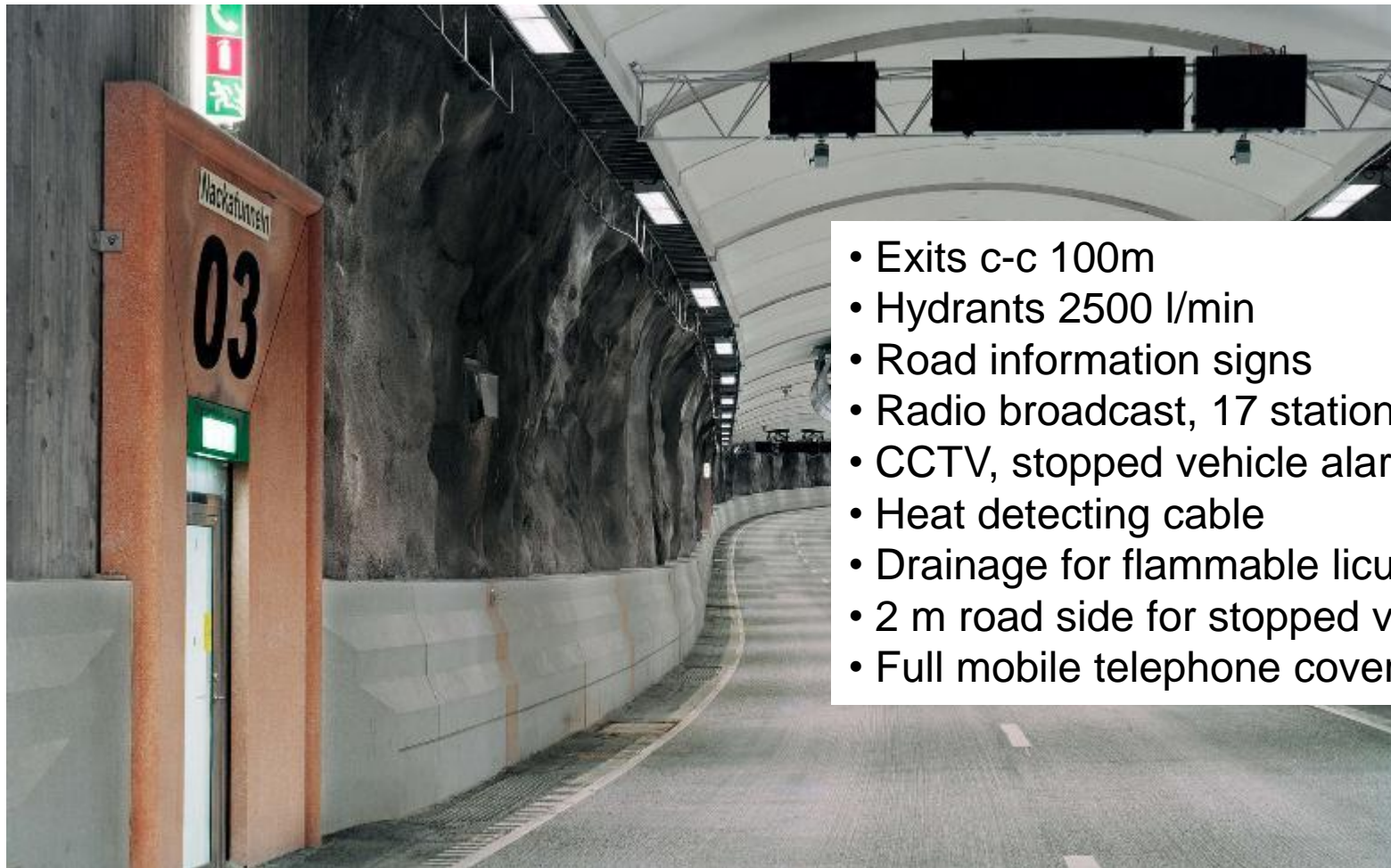
- Exits c-c 100m
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- CCTV, stopped vehicle alarm
- Heat detecting cable
- Drainage for flammable liquids

Safety concept at the Millenium: Southern Link 2004



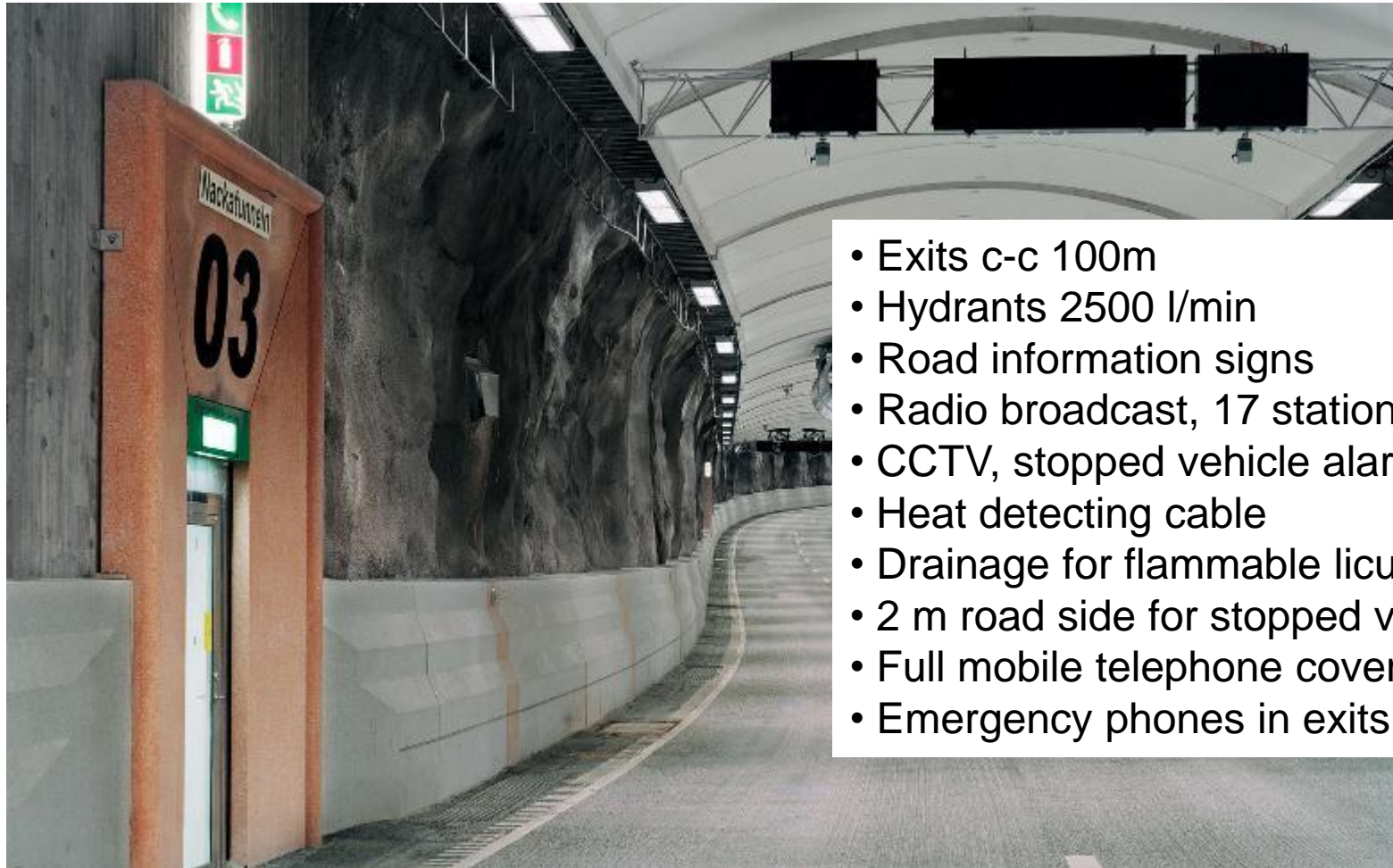
- Exits c-c 100m
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- Radio broadcast, 17 stations
- CCTV, stopped vehicle alarm
- Heat detecting cable
- Drainage for flammable liquids
- 2 m road side for stopped vehicles

Safety concept at the Millenium: Southern Link 2004



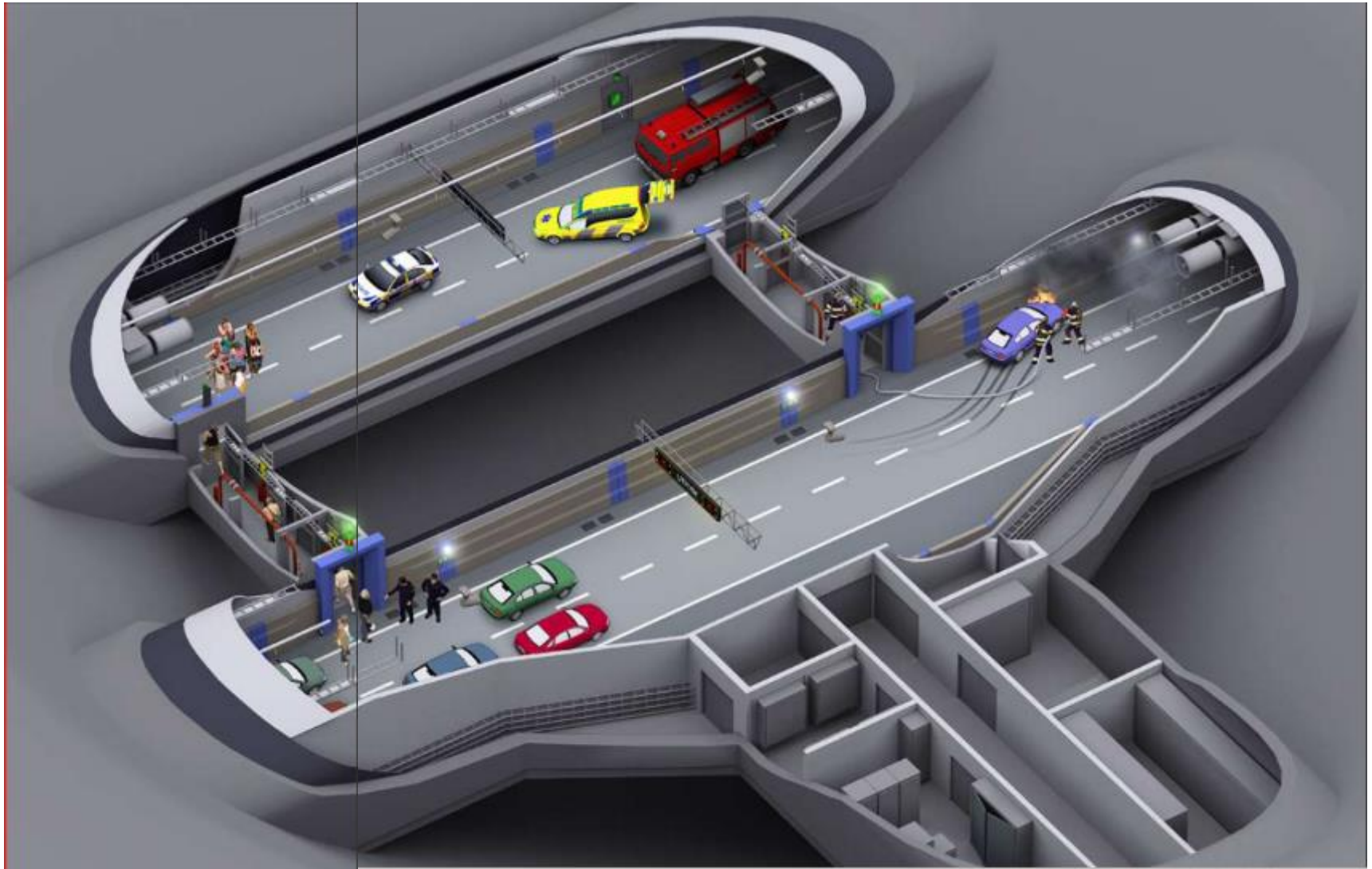
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- Radio broadcast, 17 stations
- CCTV, stopped vehicle alarm
- Heat detecting cable
- Drainage for flammable liquids
- 2 m road side for stopped vehicles
- Full mobile telephone coverage

Safety concept at the Millenium: Southern Link 2004



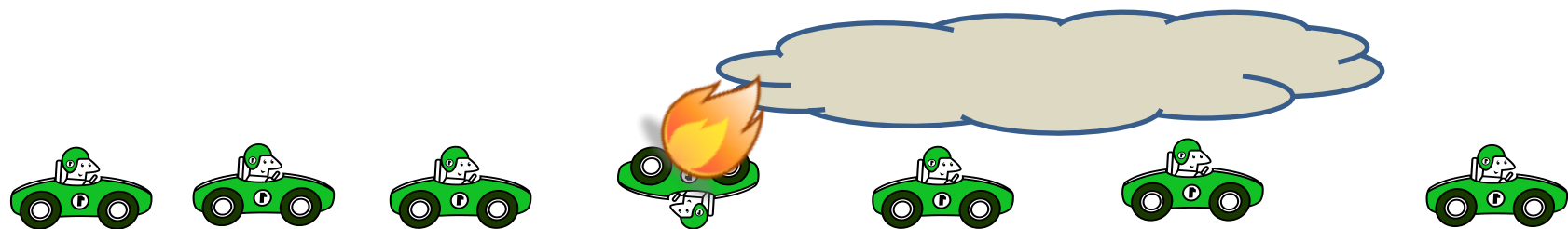
- Exits c-c 100m
- Hydrants 2500 l/min
- Road information signs
- Radio broadcast, 17 stations
- CCTV, stopped vehicle alarm
- Heat detecting cable
- Drainage for flammable liquids
- 2 m road side for stopped vehicles
- Full mobile telephone coverage
- Emergency phones in exits

Safety concept at the Millenium: Southern Link 2004

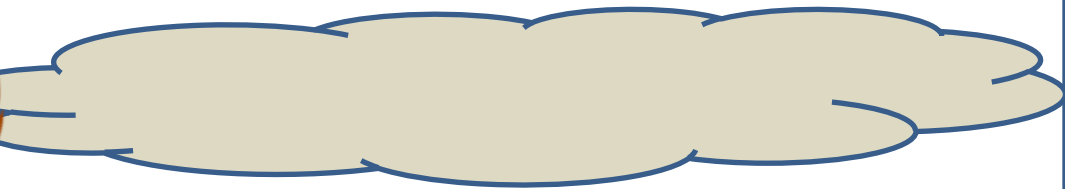


Basic fire safety concept: Free flow traffic





Fresh air

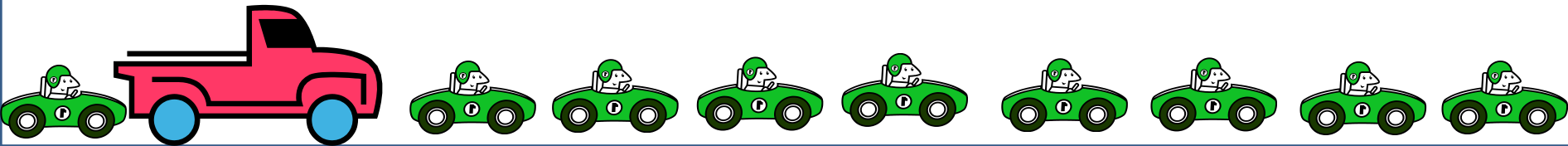


2004:

Southern Link opens for traffic:

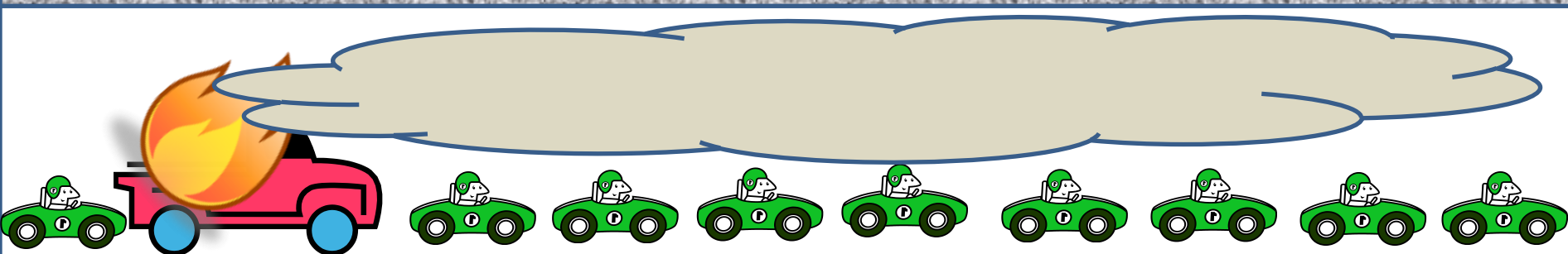
100 000 vehicles /day, estimated 60 000.

= Slow traffic



2004-2012:

The tunnel closing when
cogestion occurs.



Fire size MW

Evacuation

Property

**Disturbed
Traffic**

1

Untroubled

None

Hours

5

Uncomfortable

Minor

10

Disturbed

Days

15

Critical

Weeks

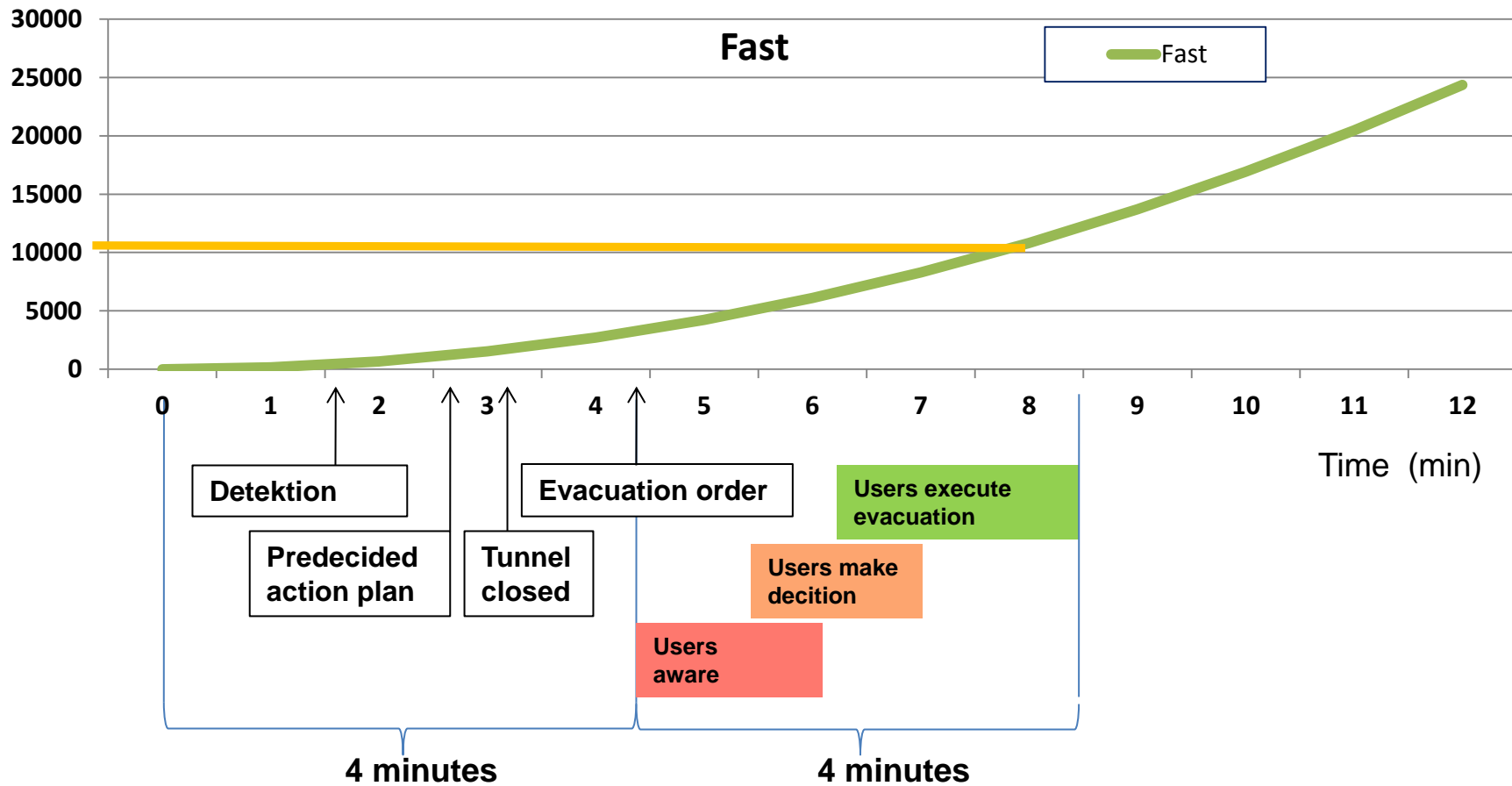
20

Unacceptable

Noticeable

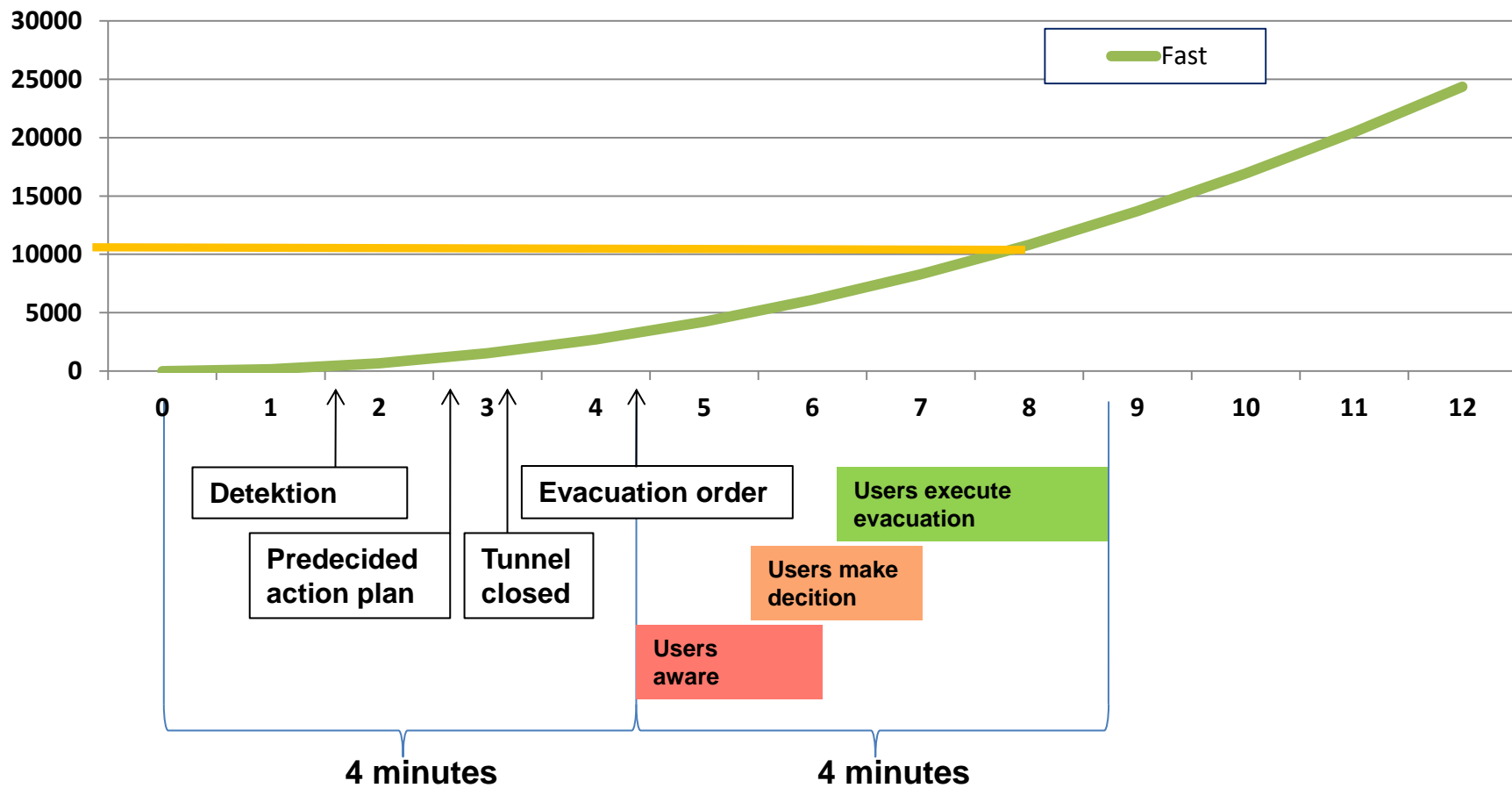
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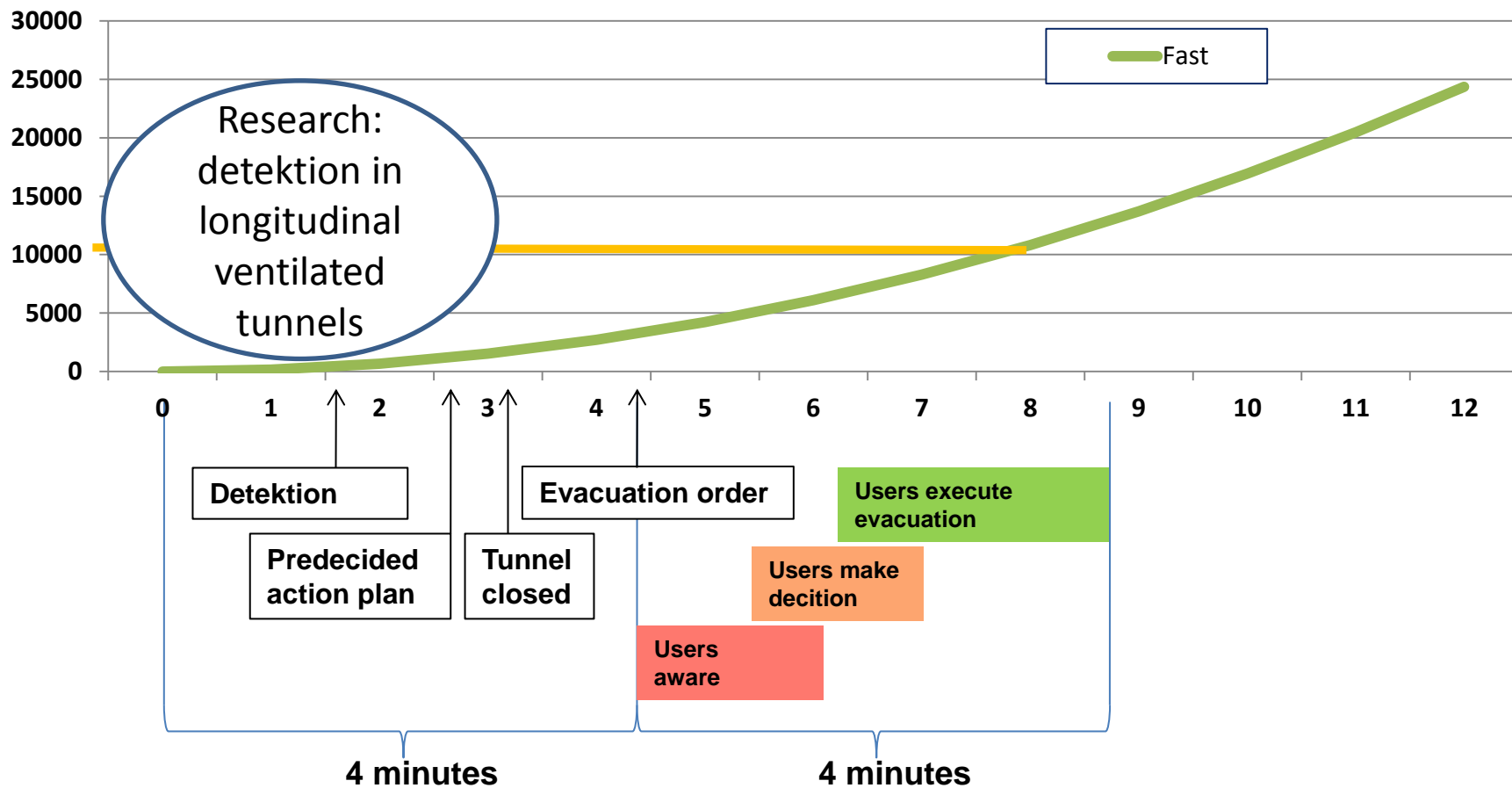
Fire size (kW)



The general safety concept of the Swedish road tunnels needs upgrading in four aspects:

- Improved detection
- Improved traffic control and management
- Improved message handling to users
- Simplified Fixed Fire Fighting System



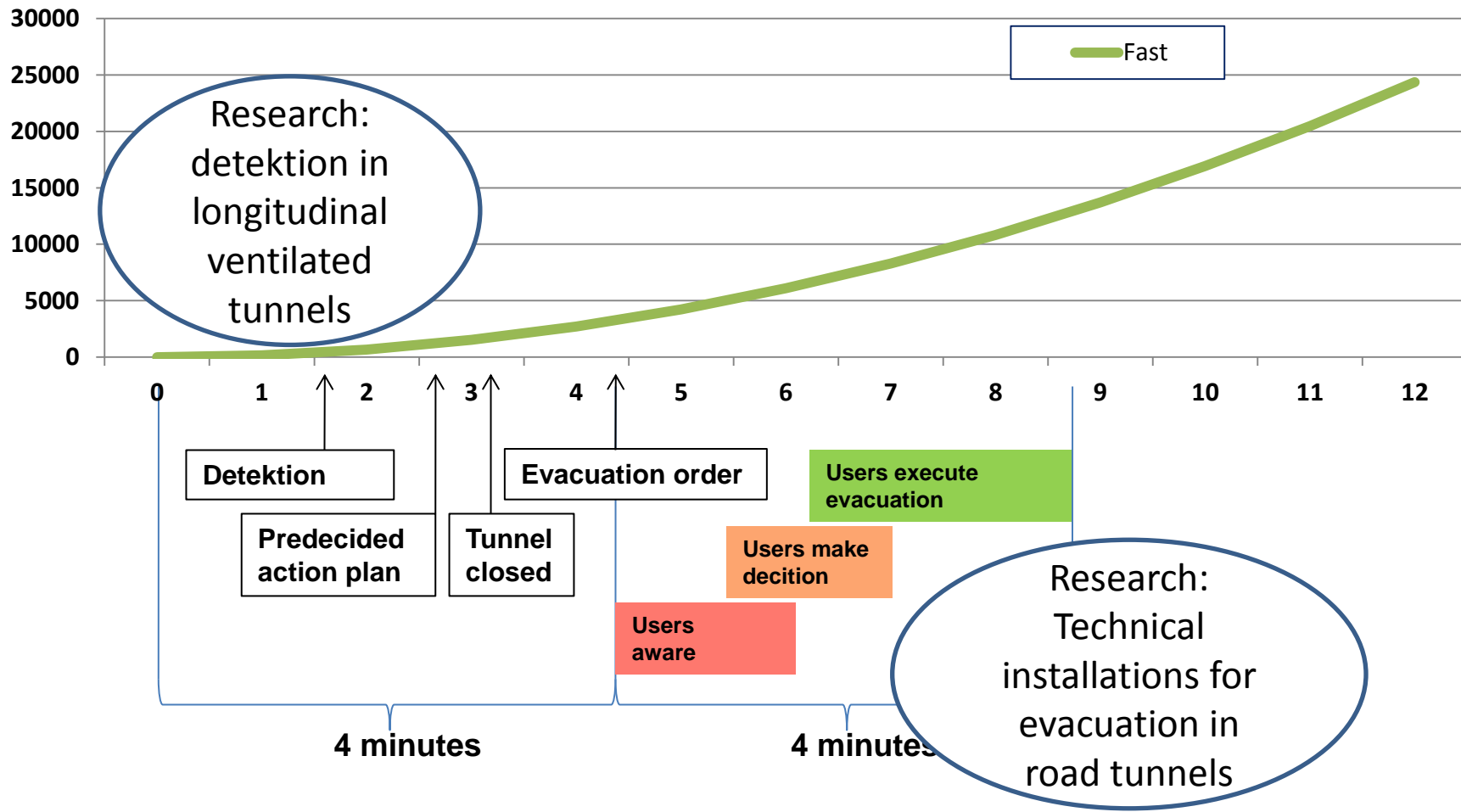


Full scale detection tests by SP:

- Smoke detectors
- Heat sensing cable
- Flame detectors
- Gas analyse detectors



Goal:
To identify systems that could
give a pre-alarm from a shielded
1 MW fire at 6 m/s within 90 sec.

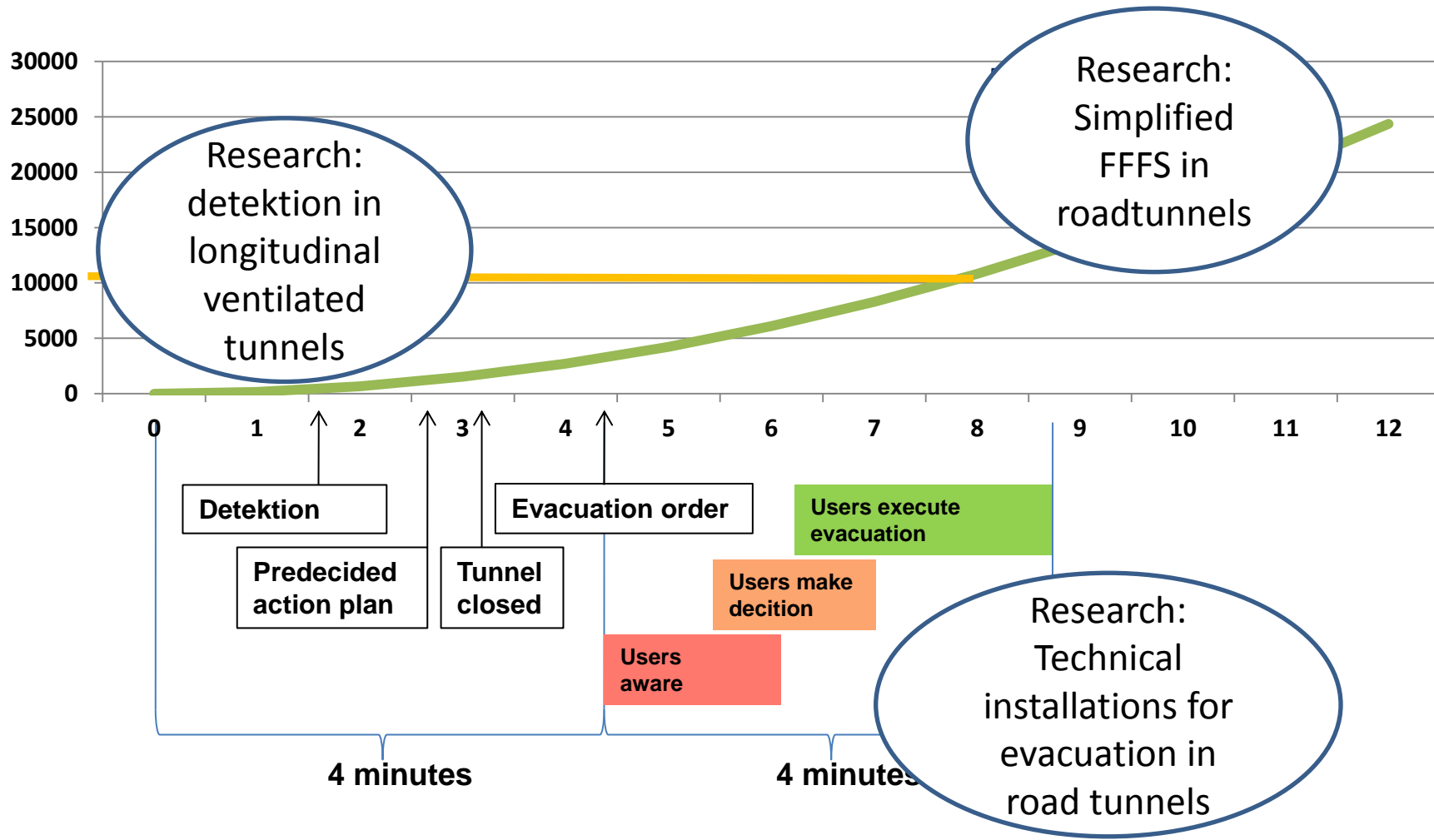


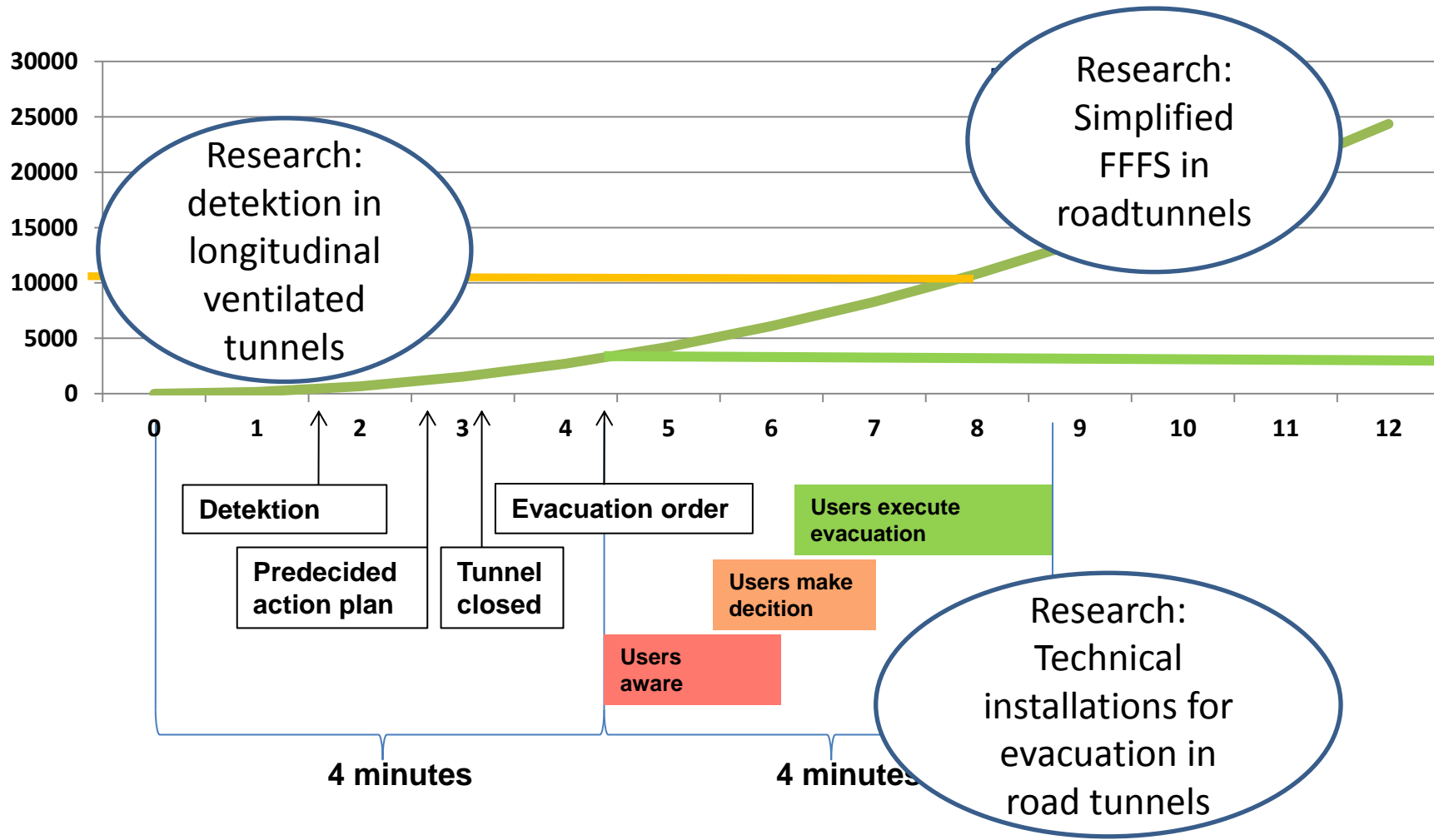
Evacuation of road tunnels

- Research at University of Lund
- Funded by Swedish transport administration and EU
- Conducted in virtual reality environment
- Shall give detailed suggestion of the technical facilities for evacuation (signs, lightning, sound etc)

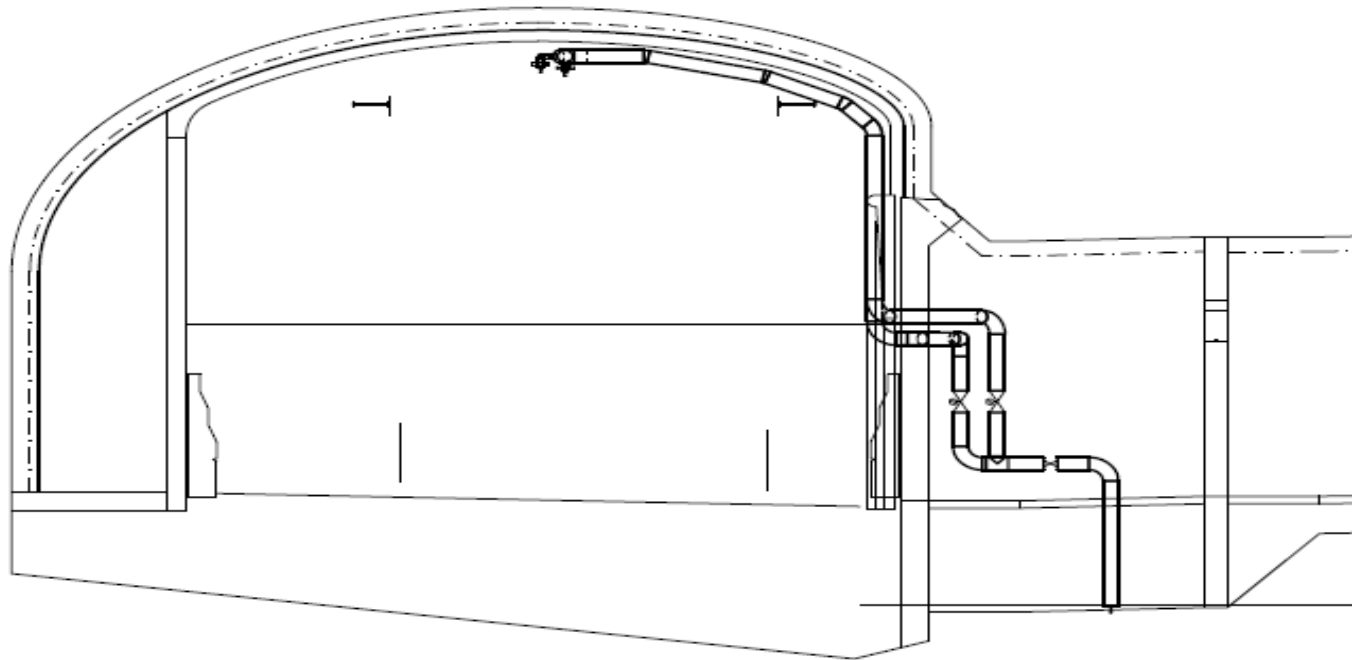


Picture from Lund University





Simplified FFFS: Example from the project Norra länken (Northern link)



Research at SP Brandteknik, Borås

Water distribution tests for different nozzels



Research at SP Brandteknik, Borås

Sprinklertests at burning fuel spillages



Test riggs in Törnskogstunneln, Stockholm

Two full scale test sections:

50 m fitted with TYCO SW24 (= Norra Länken), density 5 mm/min, tunnel width 12 m

24 m fitted with TYCO "T-rex" prototype (= Förbifart Stockholm), vattentäthet 10 mm/min, tunnelbredd ca 15 m



Tests in Törnskogstunneln, Stockholm

- Water distribution tests at different air speeds
- Visibility in a activated section
- Visibility from a moving car in a activated section
- Test of evacuation by foot through a activated section
- Fire tests: risk of fire spread between vehicles, 6 MW propan flame
- Activation in winter conditions (- 6 grader C)



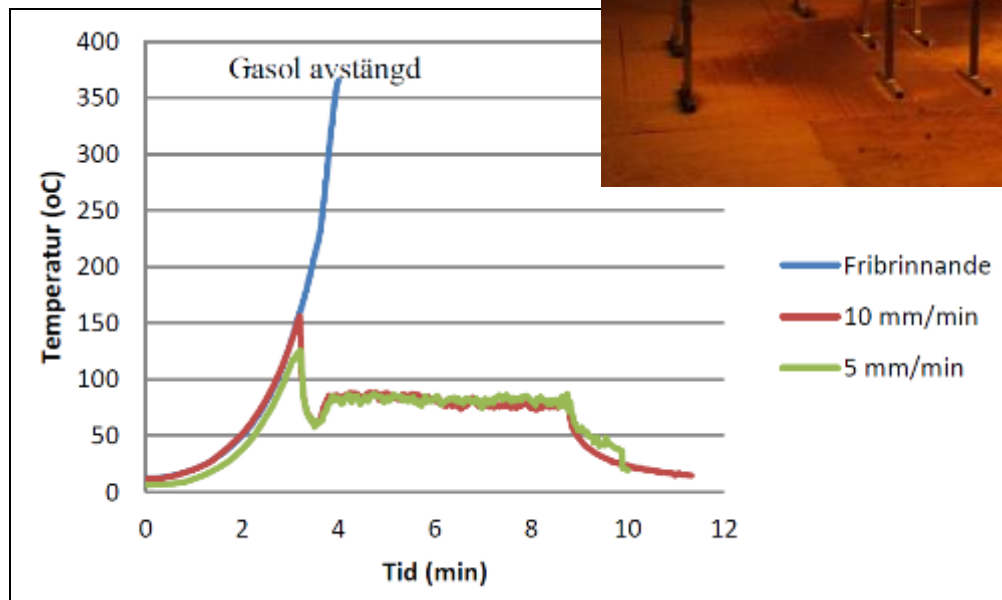
Corrosion tests at SWEREA-KIMAB

Test of different sprinkler components corrosion resistance at SWEREA-KIMAB, laboratory test and two reports.



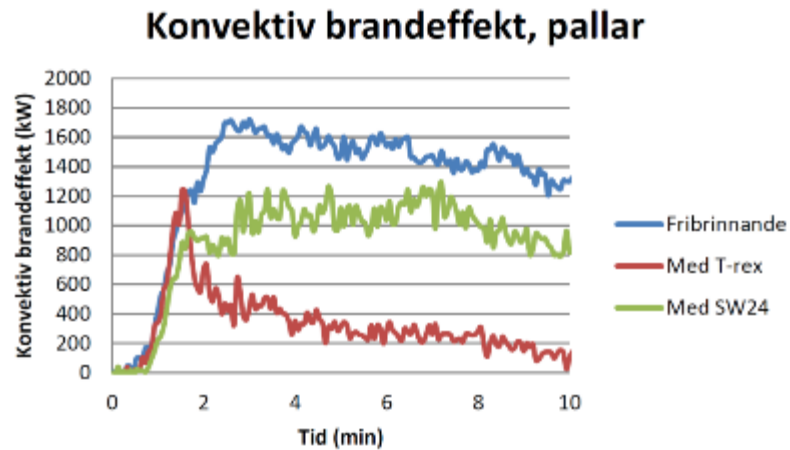
Example of test results:

Fire spread i
longitudinal ventilated
tunnels with FFFS



Example of test results:

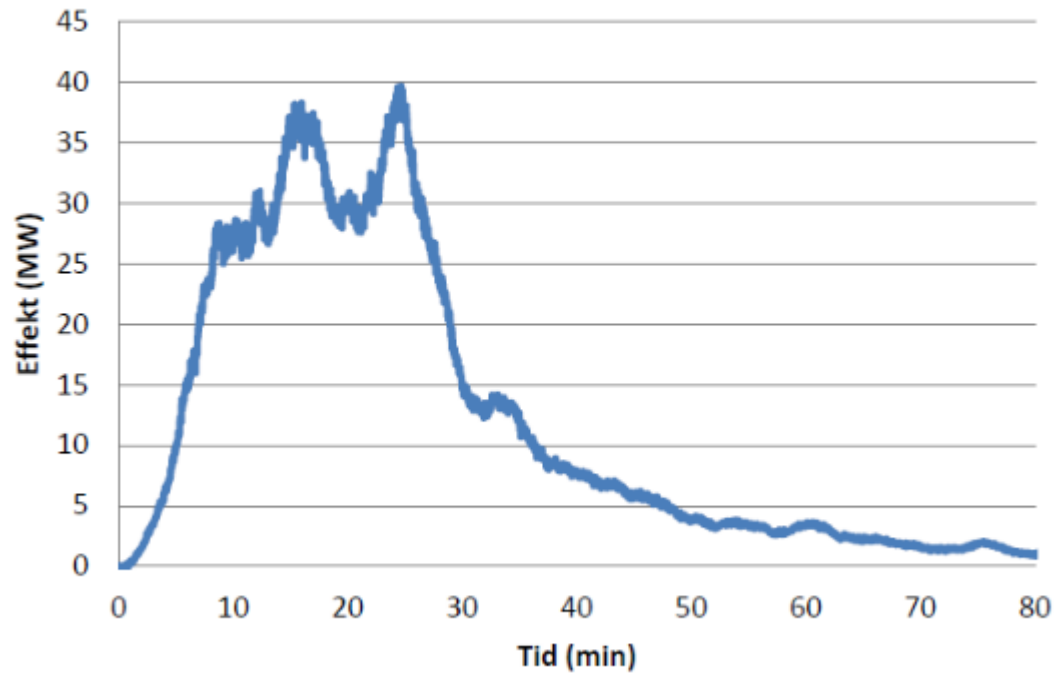
Different nozzles effect of fires in wooden pallets



Figur 17 Skillnad mellan T-Rex och SW24 vid liknande påföringstid.



Effektutveckling





Samfinansierat av EU
Transeuropeiska transportnätet (TEN-T)



TRAFIKVERKET



00:03



“Anything may happen; everything is possible and probable”
August Strindberg, “The dream play” 1901

*“Anything may happen; everything is possible and probable”
August Strindberg, “The dream play” 1901*



Airplane in the Southern link tunnel 2007

*“Anything may happen; everything is possible and probable”
August Strindberg, “The dream play” 1901*



*Buss hit by ground drill coming through the ceiling in the Southern link tunnel
2012*