Safety aspects of the tunnels reserved for passenger cars in the A86 project near Paris

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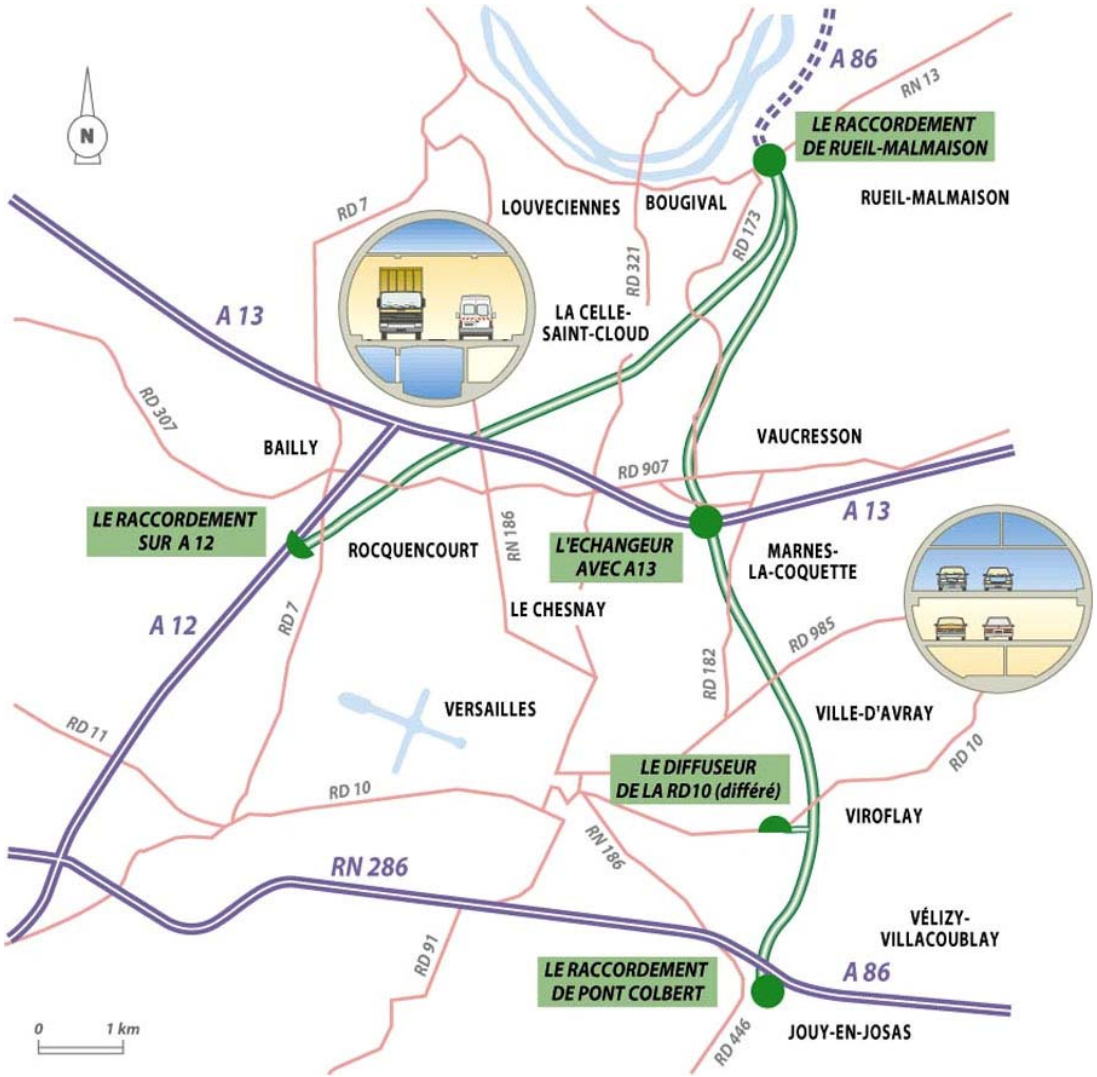
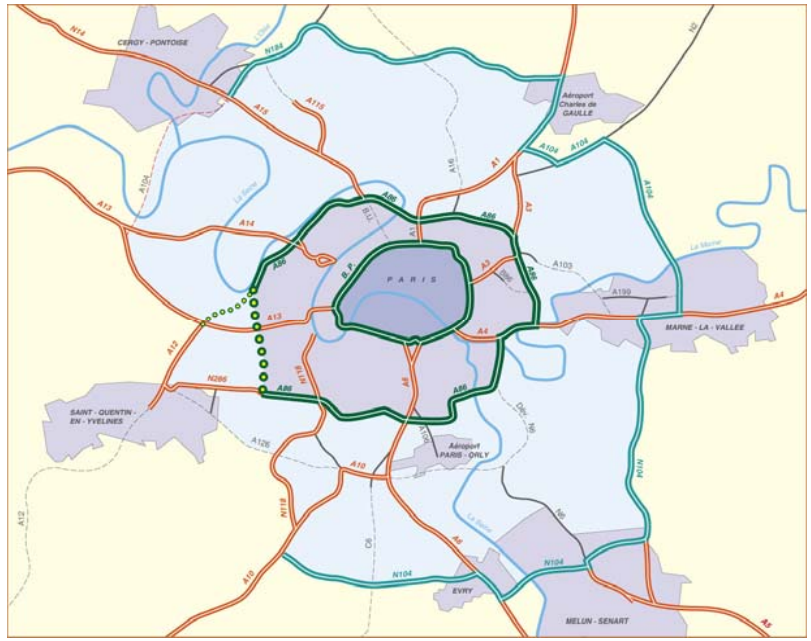
COFIROUTE

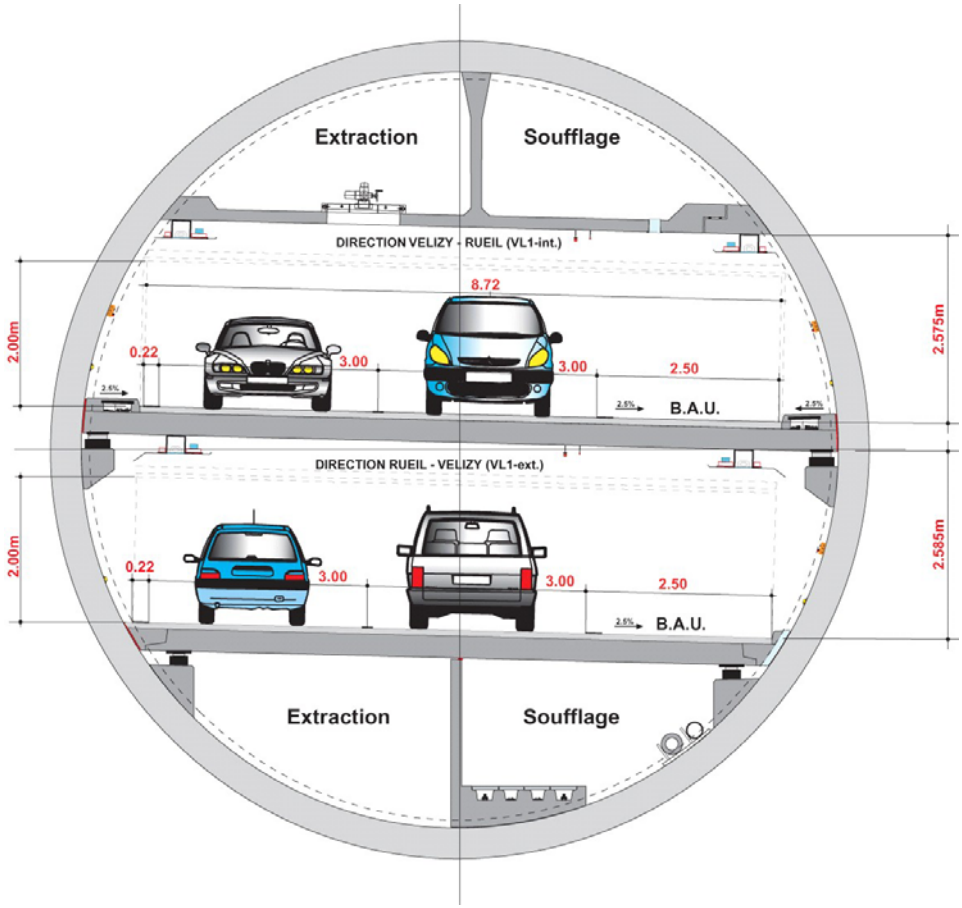
« Duplex A86 »: The project declared of public utility (December 1995)



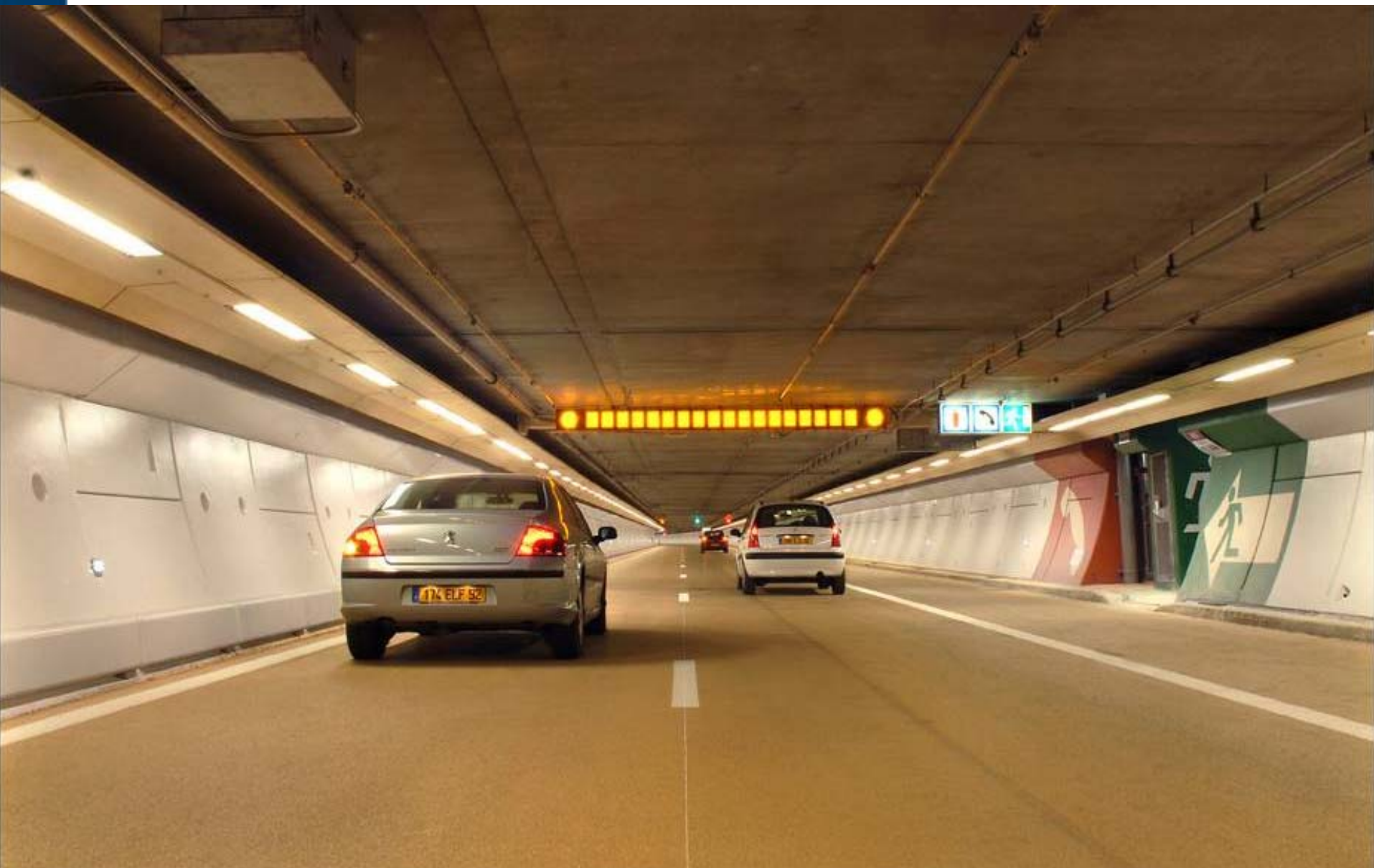


« Duplex A86 »: the double deck tunnel

- Length : 10 km
- Inside diameter : 10.40 m
- Clearance : 2.55 m
- Maximum height of vehicles : 2 m
- Intermediate underground interchange
- Cost 1700 M€
- DBFO contract
- 70 years concession
- Finance by Cofiroute (no public fundings)
- Toll level from 2 to 7 € per trip



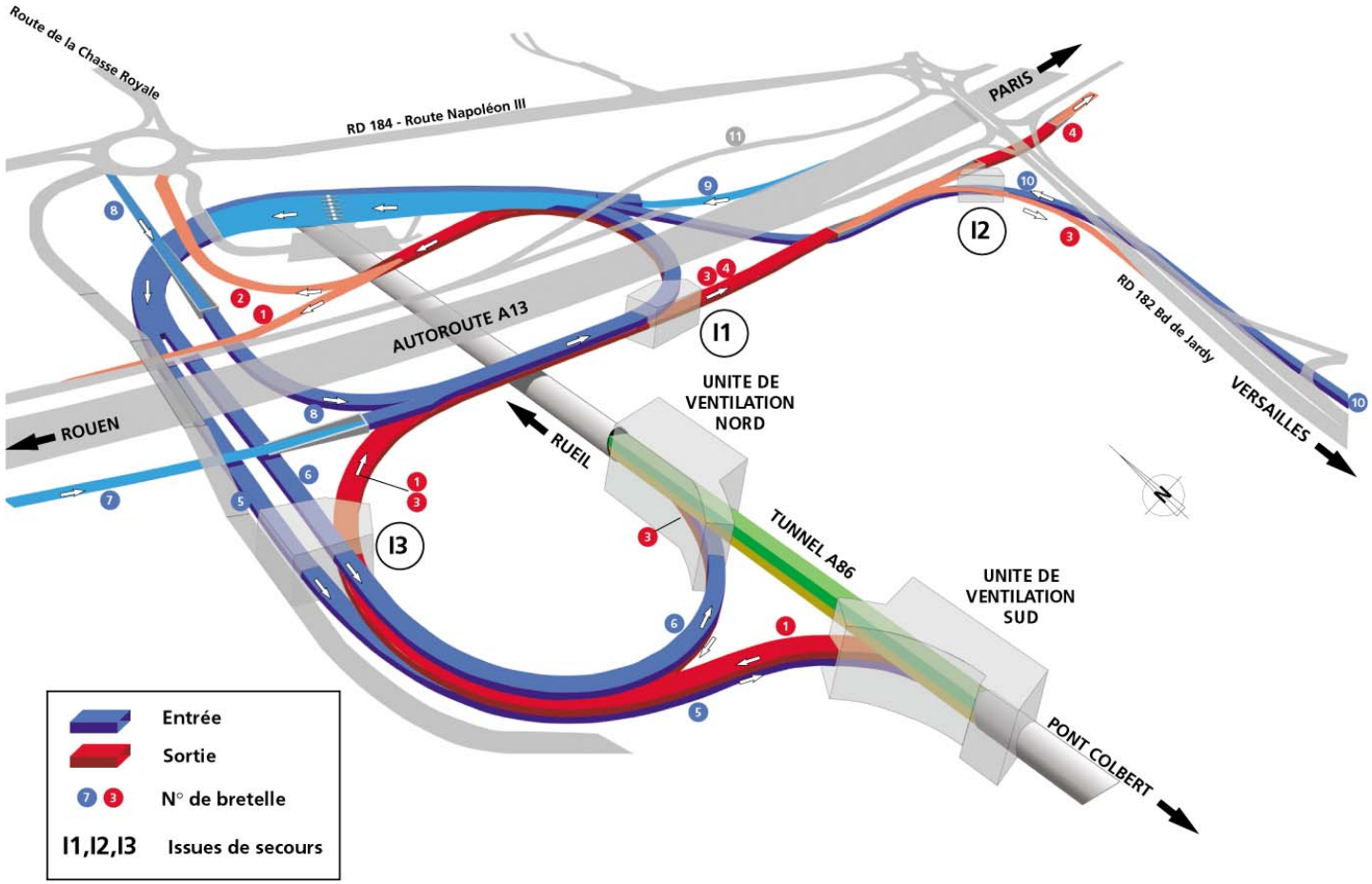
First section will open in June 2008



The A86 / A13 underground interchange

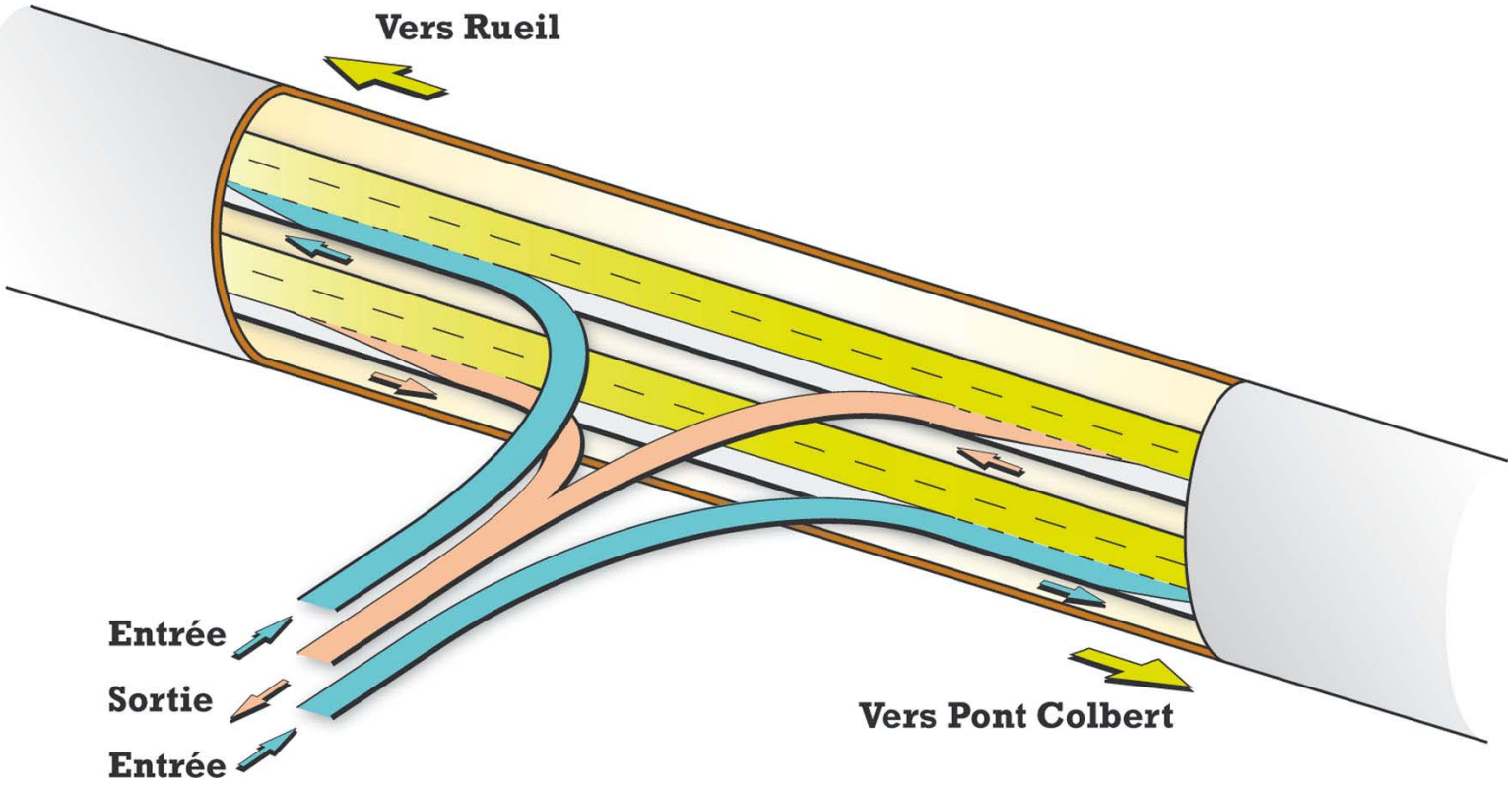
- 4 ramps with the A13 highway
- 4 ramps with local roads
- 3 km of secondary tunnels for the ramps
- One toll plaza

The A86 / A13 underground interchange:



- Very reduced surface consumption
- sophisticated for the designer but simple for the customer

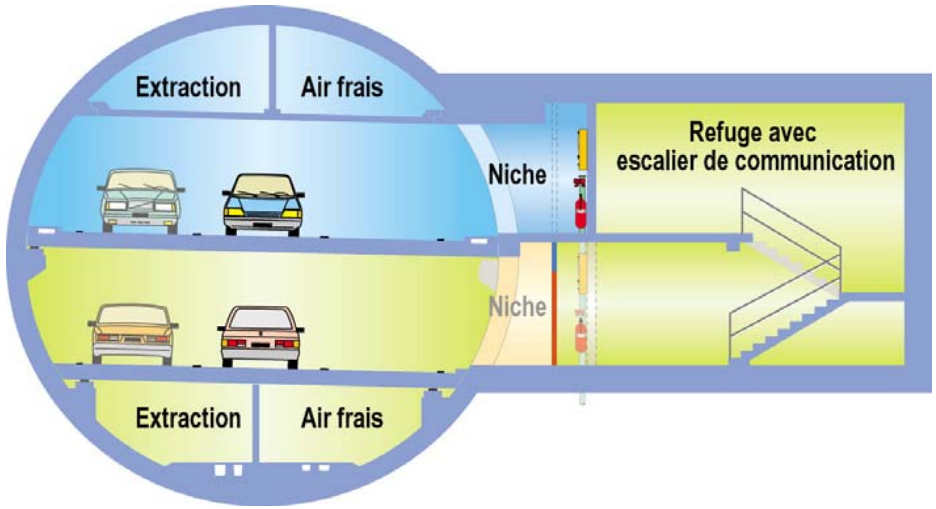
The underground ramps: principle

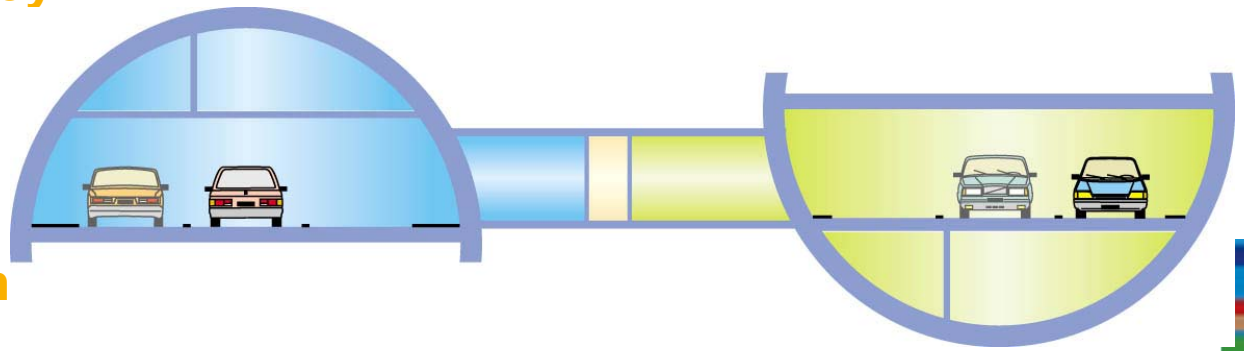


- Ramps are on the left side in the upper deck
- Ramps are on the right side in the lower deck
- In the tunnel there is a dedicated lane for the ramps

The double deck tunnel : « Two tunnels in one related every 200 m »

- For operation the tunnel acts as two independent tunnels (one per direction), interconnected every 200m by stairs with shelters
- In case of accident in one tube, emergency crews can access through the other tube
- Independent ventilation for each level





Focus on safety

- Specific safety issues to be solved

- Specific benefits
  - ➔ homogeneity of vehicles
  - ➔ no heavy trucks

- Additional equipments

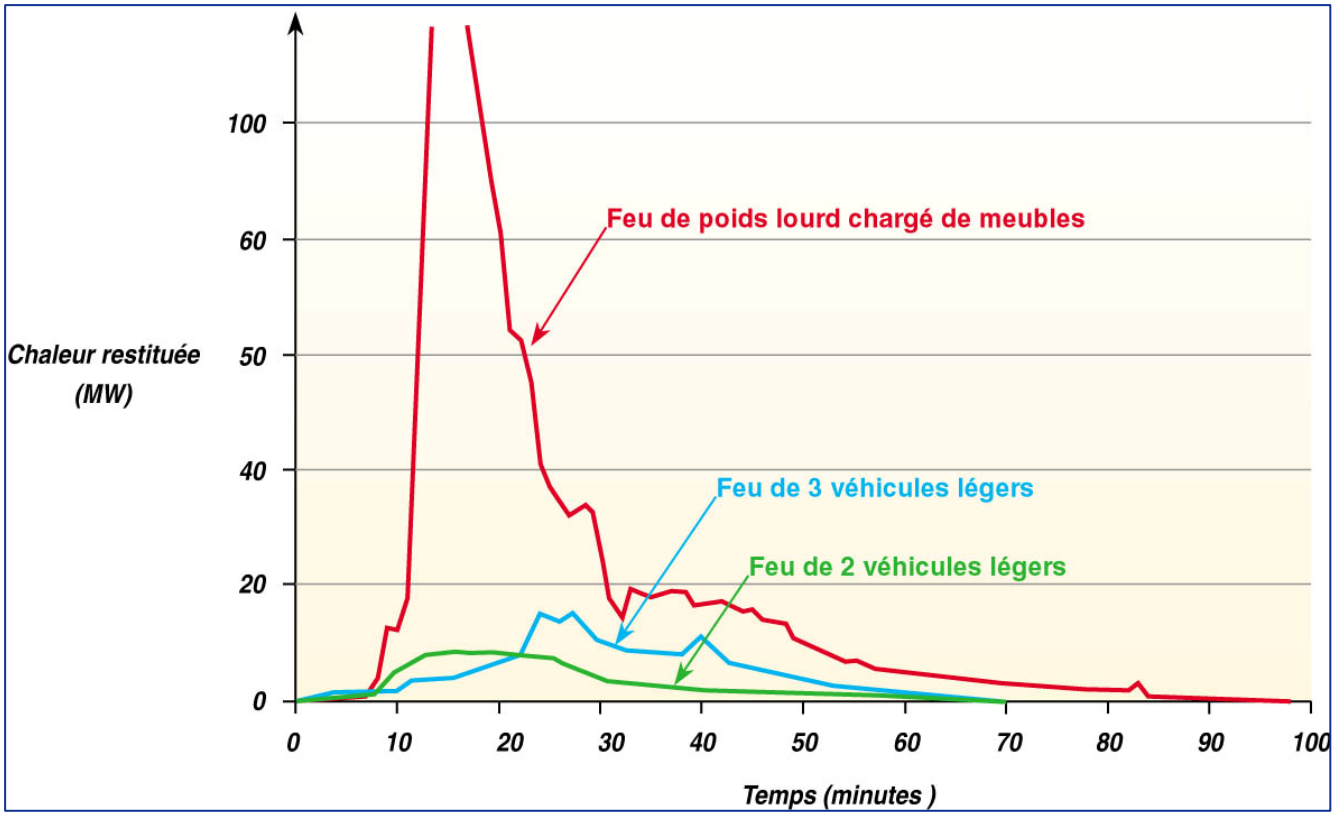
Specific safety issues to be solved

- Access of emergency vehicles
  - ➔ Specially designed emergency vehicles
- Absence of smoke stratification
  - ➔ Demand is monitored by pricing to keep the tunnel free of congestion
  - ➔ Longitudinal ventilation
  - ➔ Very low fire intensity
- Psychological effects
  - ➔ Special studies and design

Benefits: traffic homogeneity

- Reduction of the frequency of accidents
- Reduction of the importance of accidents
- Reduction of the importance of fire
- The Incident Automatic Detection is much more efficient (no mask effect)
  - ➔ 450 cameras
  - ➔ detection rate : 99.8 %

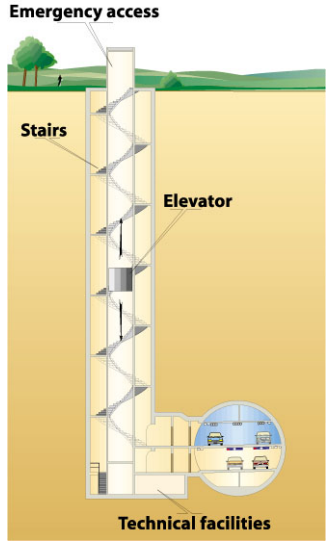
Benefits: no heavy trucks; the risk of a major fire is highly reduced



- The energy produced by a light car in fire is ten times lower then by a heavy truck
- As a consequence the temperature increase in the tunnel is 3 to 5 times lower
- Smoke control is nevertheless designed for a 15MW fire

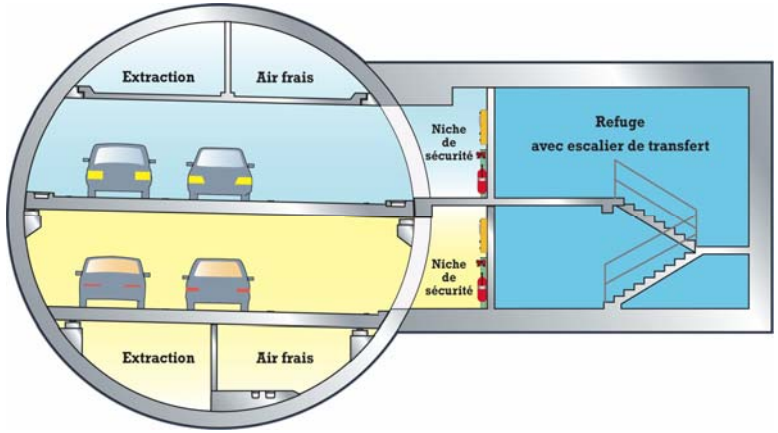
Additional equipments

- 12 emergency accesses
- Monitoring of air pressures
- Water mist

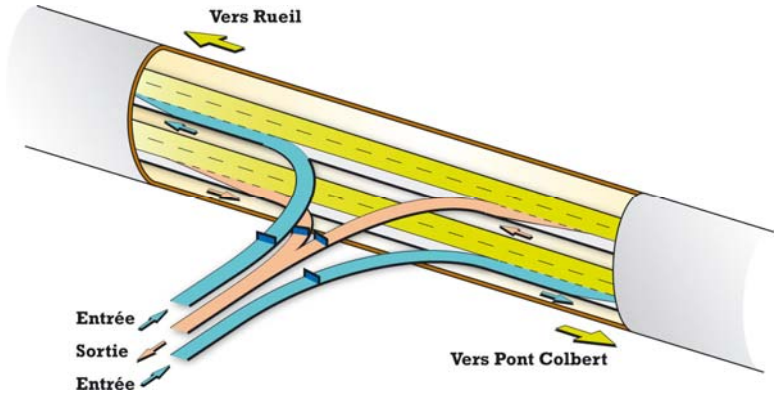


Ventilation: monitoring of air pressures

- **Monitoring of air pressures in case of fire**
  - ➔ **Lower deck : « P1 »**
  - ➔ **Upper deck : « P2 = P1 + ΔP »**
  - ➔ **Shelters : « P3 = P2 + ΔP »**

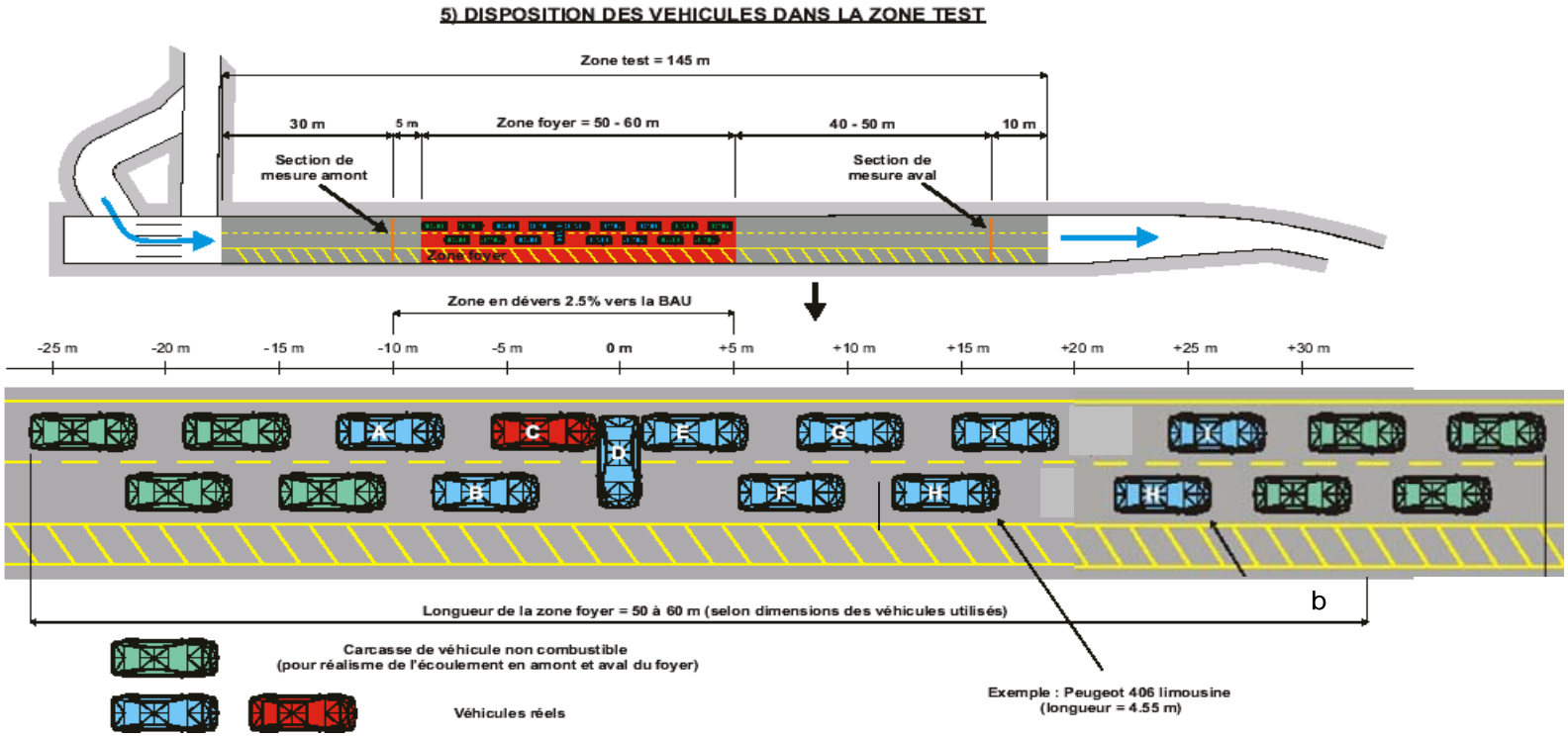


- **Air curtains in the ramps at the intermediate underground interchange**

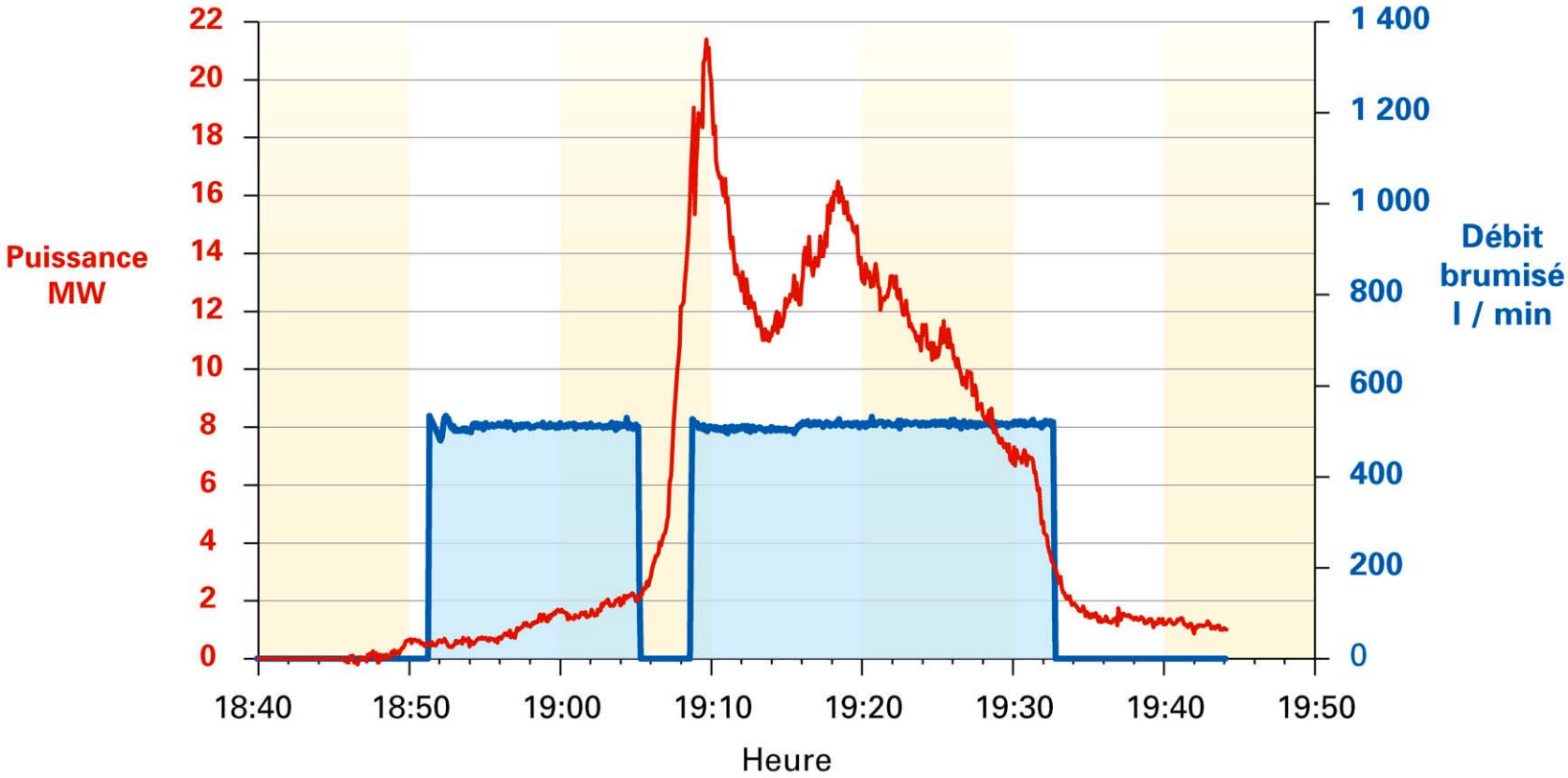


Water mist tests

- Real conditions (more than 20 tests)
- First accident + traffic jam + new accident + fire



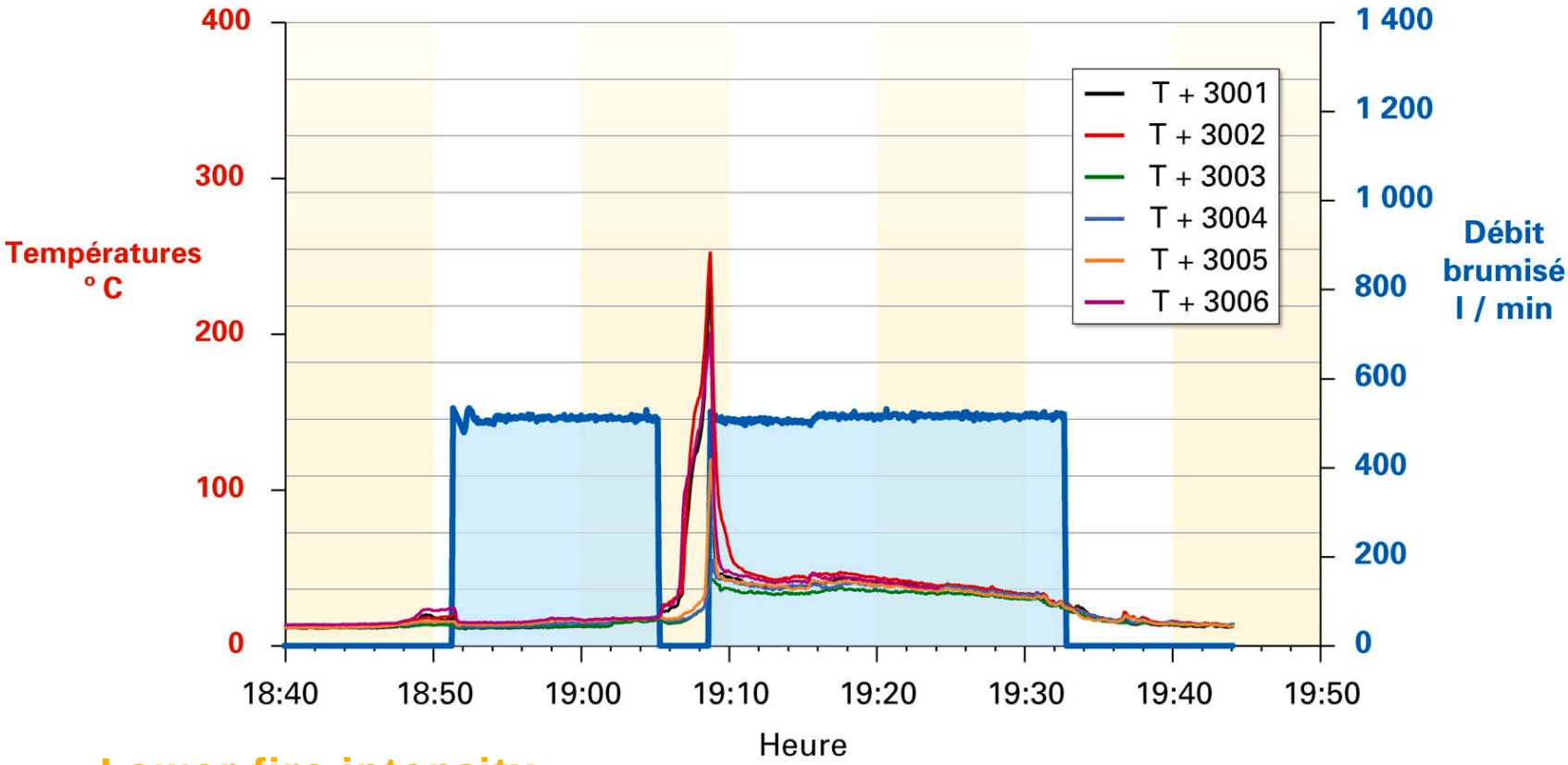
Effect of the water mist on fire intensity



Puissance et énergie libérée (essai C 26-11-03)
(estimation par consommation O2 et production CO/CO2)

- **Fire is under control even in the case of a traffic jam**

Effect of the water mist on down stream temperature



- Lower fire intensity
- + effect of the water mist on the intensity
- + effect of the water mist on down stream temperature
- = Down stream conditions are acceptable for drivers (less than 50°C)
- Decision to install a Marioff water mist