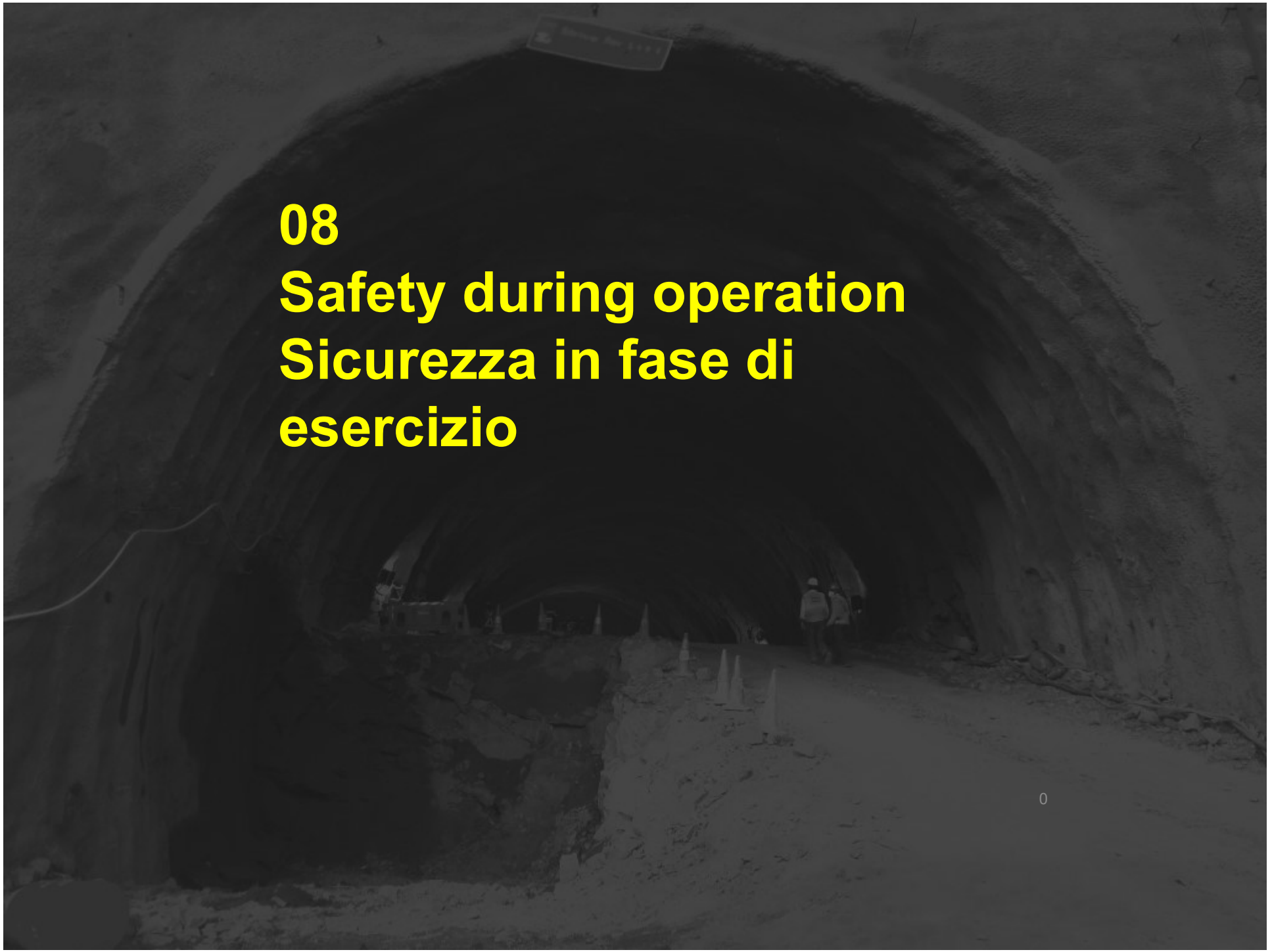


08
Safety during operation
Sicurezza in fase di esercizio

The main difference in safety

Railway tunnel: traffic is managed by a single point of control

Road tunnel: traffic is managed by multiple actors

Road tunnel

D.Lgs. 264/06 (Direttiva 2004/54/CE) Requisiti Minimi di Sicurezza per le Gallerie Stradali della Rete Transeuropea

ANAS Circolare n° 17/06 "Linee Guida per la progettazione della sicurezza nelle Gallerie Stradali ."

Manuale Organizzazione Mondiale della Strada AIPCR - PIARC) (vers .1.1 – 27 ottobre 2015)

NFPA 502 USA National Fire Protection association Standard for Road Tunnels, Bridges, and Other Limited Access Highways
EU/2004/54/EC Directive 2004/54/EC Minimum safety requirements for tunnels in the Trans-European Road Network
Circ. 2000 – 63A2 (France)
RABT 2006 (Germany)
RVS 9.281 / RVS 9.282 (Austria)

Railway tunnel

Decreto Ministeriale 28 ottobre 2005 : Sicurezza nelle gallerie ferroviarie

Ferrovie : Revisione SRT TSI – STI (specifiche tecniche di interoperabilità) vigente / Revisione STI (in vigore dal 1 gennaio 2015)

DECRETO 21 ottobre 2015 Approvazione della regola tecnica di prevenzione incendi per la progettazione, costruzione ed esercizio delle metropolitane

Road tunnel: 1997-2020

autostrada del brennero s.p.a.

II conferenza su "PROTEZIONE DAL RISCHIO DI INCENDIO NELLE GALLERIE STRADALI E FERROVIARIE"
II conference on "PROTECTION FROM FIRE IN ROAD AND RAIL TUNNELS"
Roma, 21-22 giugno 1999

LA MANUTENZIONE STRAORDINARIA DELLA GALLERIA "PIEDICASTELLO": NUOVI CRITERI DI SICUREZZA

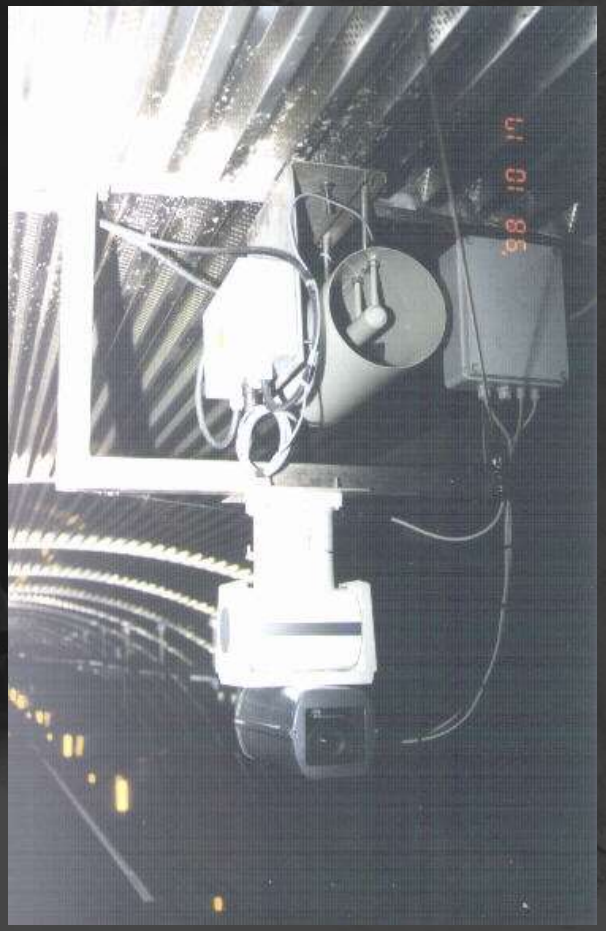
Angelo Villa

Road tunnel

SICUREZZA IN FASE DI ESERCIZIO

SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEMS (SCADA)

- Collection of information via networks in loop
- Intelligence (programmable logic control notably) installed near the equipment
- Separation of networks: acquisition, transport and supervision
- Redundancy of certain sub-assemblies for improving their dependability.



Road tunnel

1. COMMUNICATION AND ALERT SYSTEMS

- 1.1. Emergency telephones
- 1.2. Alarm pushbuttons
- 1,3, Automatic alarm when emergencysystems meant for users are used
- 1.4. Automatic incident detection
- 1.5. Fire/smoke detection
- 1.6. Radio-retransmission of public FM broadcasts, frequencies of operators and emergency services Rescue services (fire brigade, police...) Operator (patrols, maintenance crews, taxis, bus companies, ...) Public FM broadcasts Cell phones.
- 1.7. Loudspeakers

2. LIGHTING

Road tunnel

3. VENTILATION

Ventilation in tunnels has two functions:

- In normal operation, it ensures sufficient air quality in the tunnel, generally by diluting pollutants;
- In a fire situation, it should make the environment as safe as possible to the tunnel users and rescue services by controlling the flow of smoke in an appropriate way

Road tunnel

4. FIRE-FIGHTING EQUIPMENT FOR THE USERS AND EMERGENCY TEAMS
4.1. Water supply
4.2. Fire hydrants
4.3. Portable fire extinguishers
4.4. Fire hose (NASPO)

5. SYSTEMS FOR SURVEILLANCE AND CONTROL OF TRAFFIC
6. SIGNPOSTING
7. BARRIERS

Road tunnel

Monodirectional (two tubes)
Bidirectional (single tube)
Bidirectional with escape tunnel

Focus on :
- Platform liquid
- Fire estinguishing system
- Ventilation system

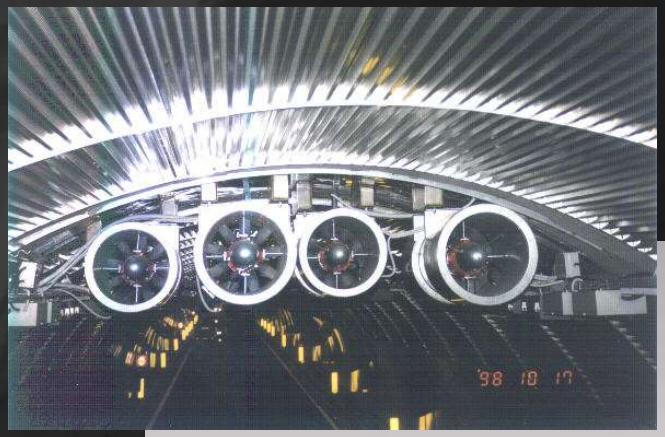
Road tunnel: ventilation

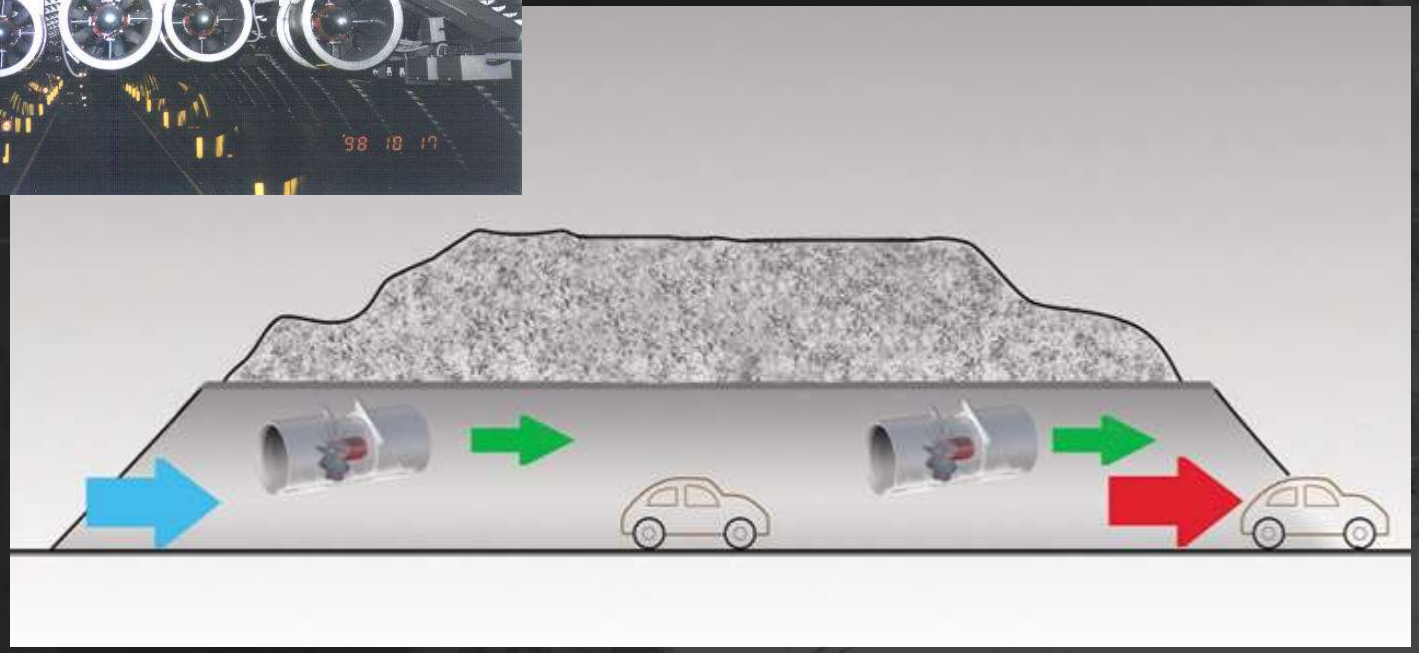
SISTEMA DI VENTILAZIONE	LUNGHEZZA GALLERIA [Km]
Ventilazione naturale	**≤ 1,0**
Ventilazione longitudinale	
Con jet-fans	**≤ 4,0**
Con jet-fans ed estrazione fumi	**≤ 6,0**
Ventilazione semi-trasversale	**≥ 2,0**
Ventilazione trasversale	**≥ 6,0**

Tabella 1 - Sistemi di ventilazione meccanizzata al variare della lunghezza del tunnel (D.lgs 264/2006)

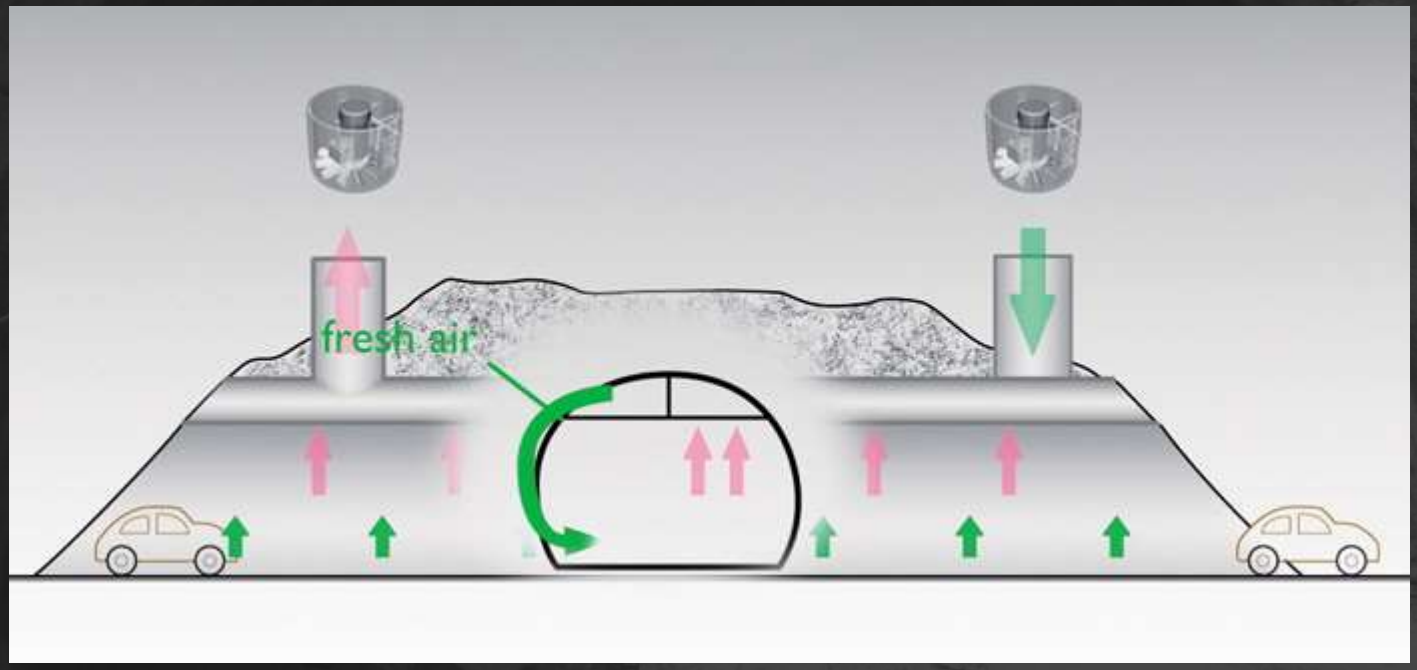
Effetto camino
Analisi della pressione barometrica alle estremità
Effetto stantuffo

Road tunnel: longitudinal ventilation

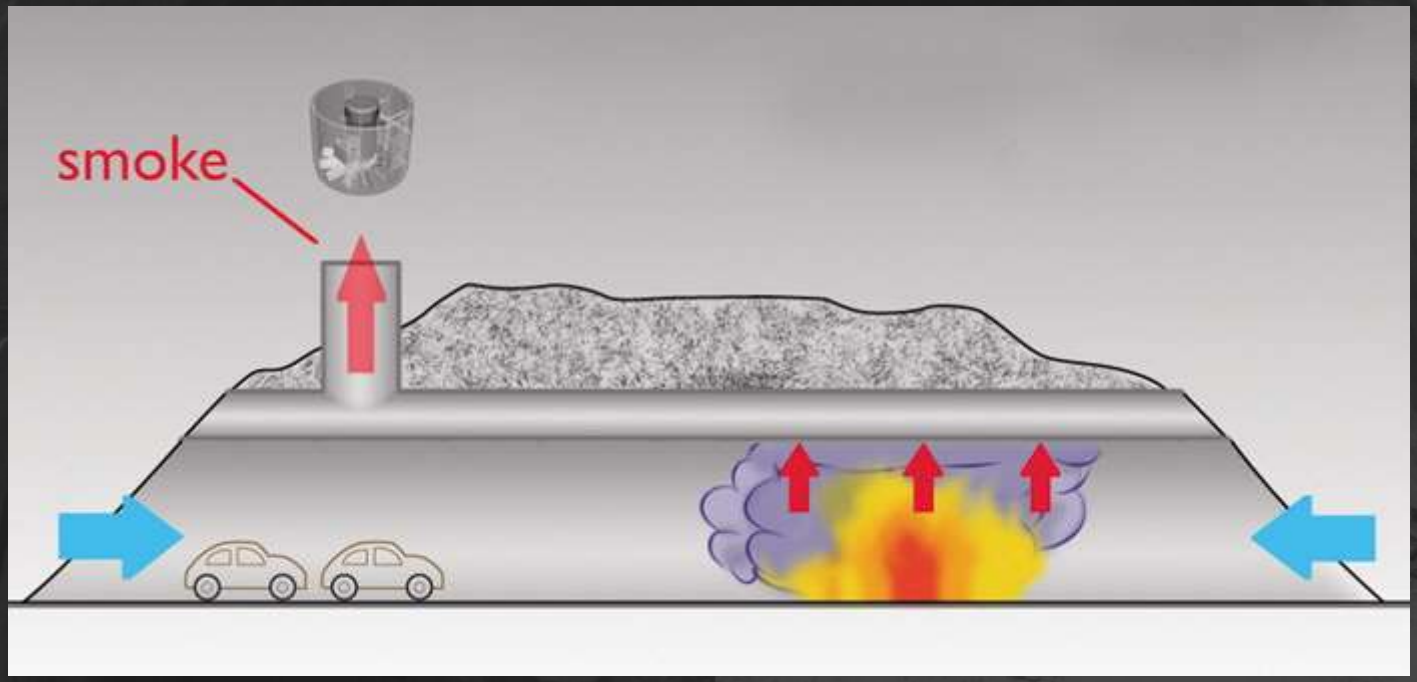




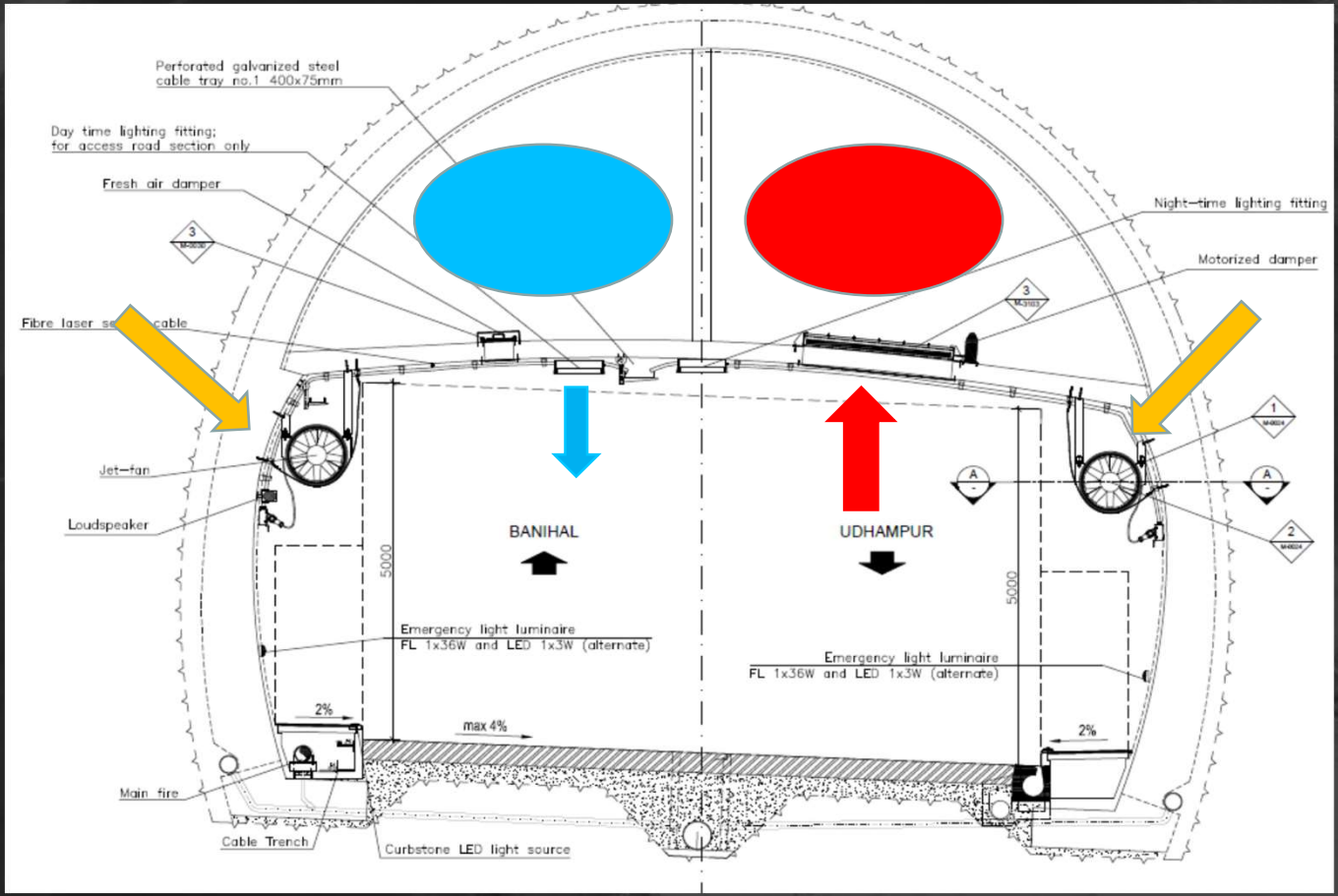
Road tunnel: transversal ventilation



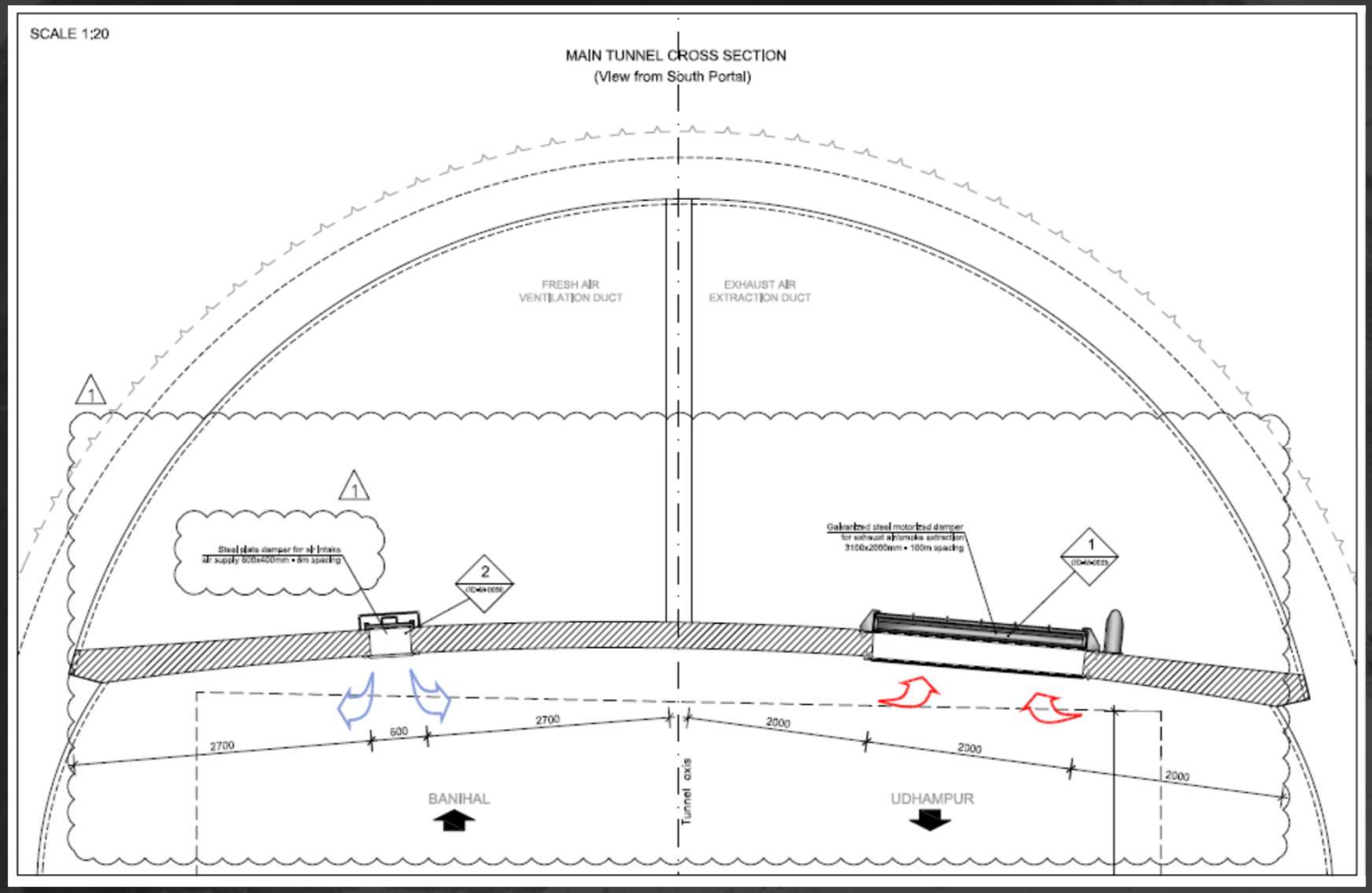
Road tunnel: semi transversal ventilation



Road tunnel: ventilation



Road tunnel: ventilation



Road tunnel: ventilation

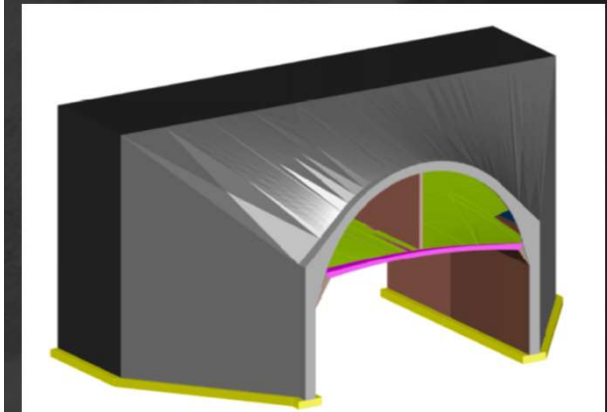
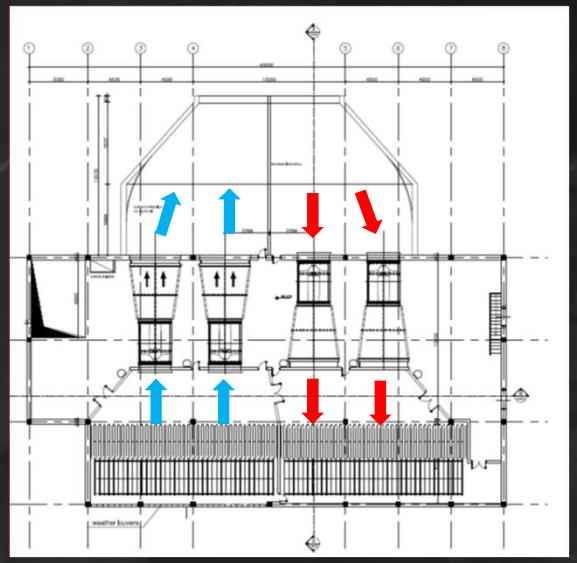
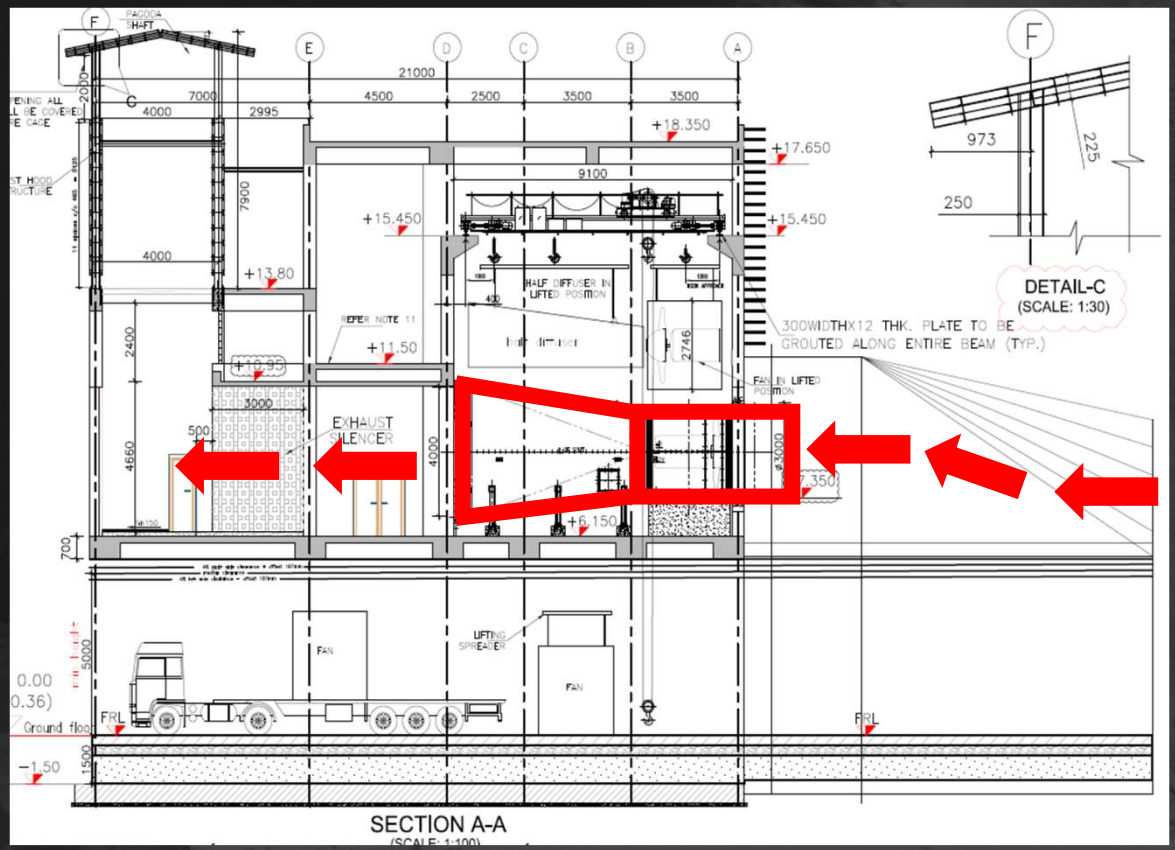


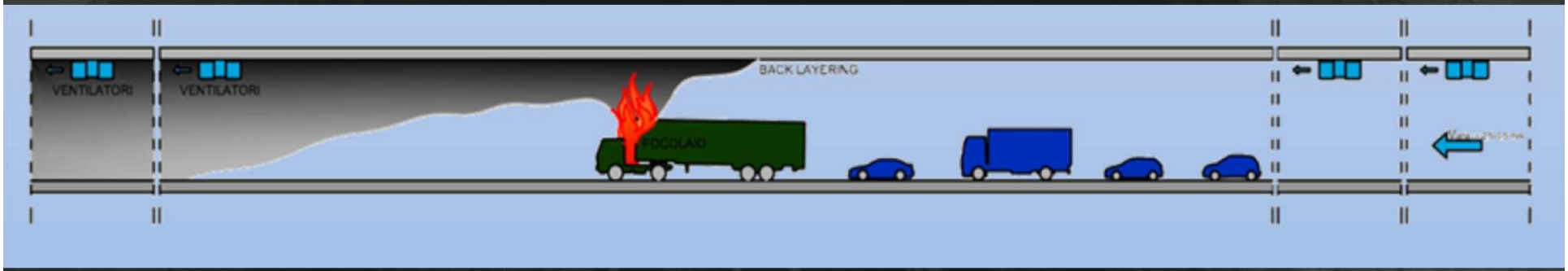
Figure 2.3 – Ventilation Building – Section view at the joint with the tunnel.





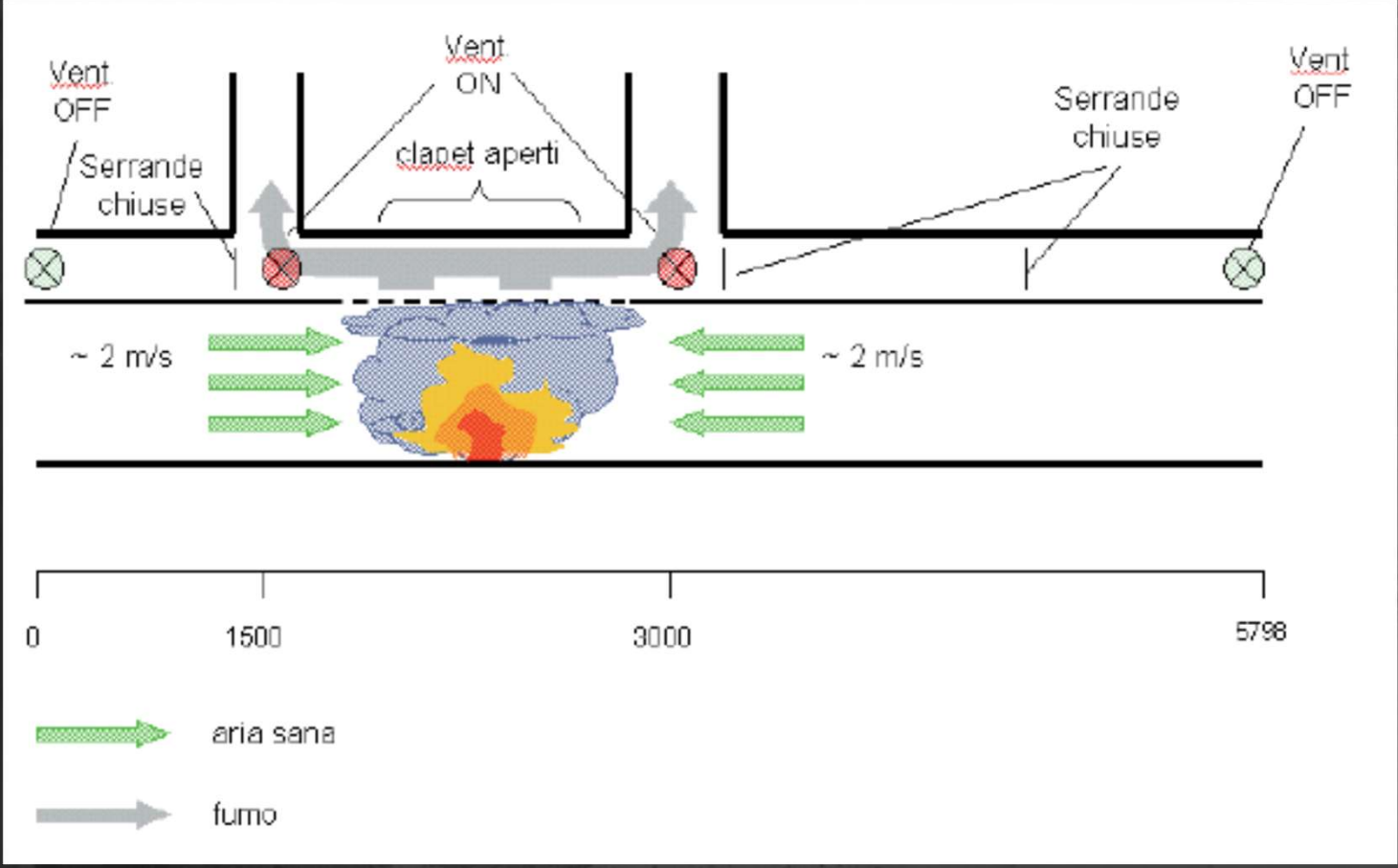
Road tunnel

longitudinal ventilation with one way traffic

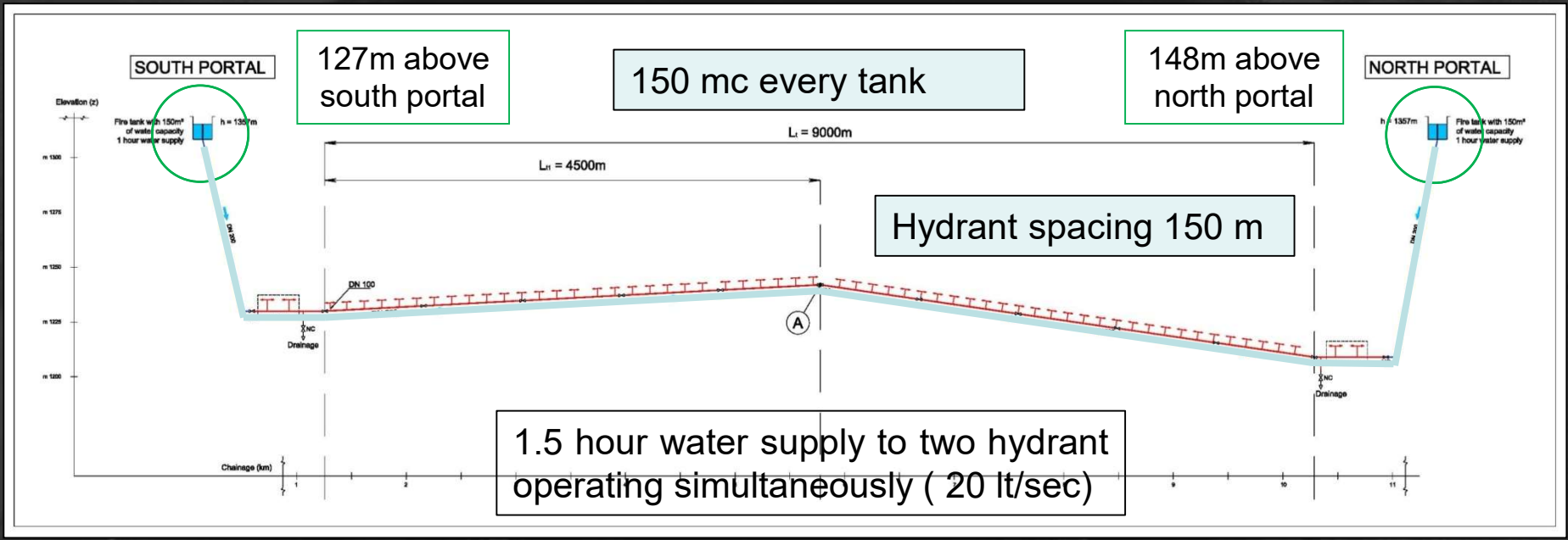


Road tunnel

ventilation with two way traffic



Road tunnel: fire fighting system



Min pressure 6 bar and max pressure 10 bar any hydrant

Fire tanks shall be filled with water captured from the neighboring

All the system permit repair of any section of the system **without reducing the fire safety** (tank partition)

NO PUMP

Road tunnel: fire fighting system

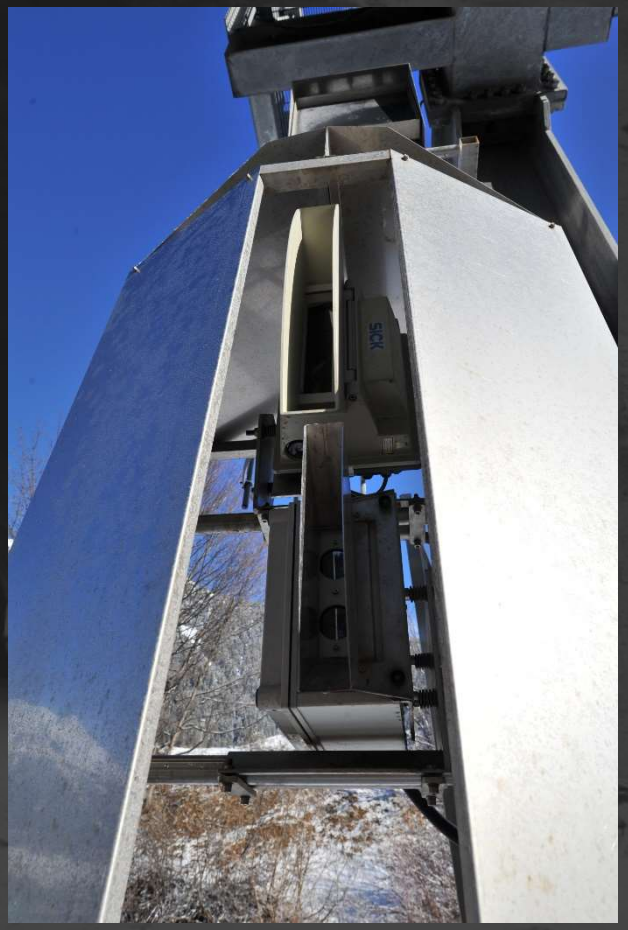
Impianto idrico antincendio

150 m

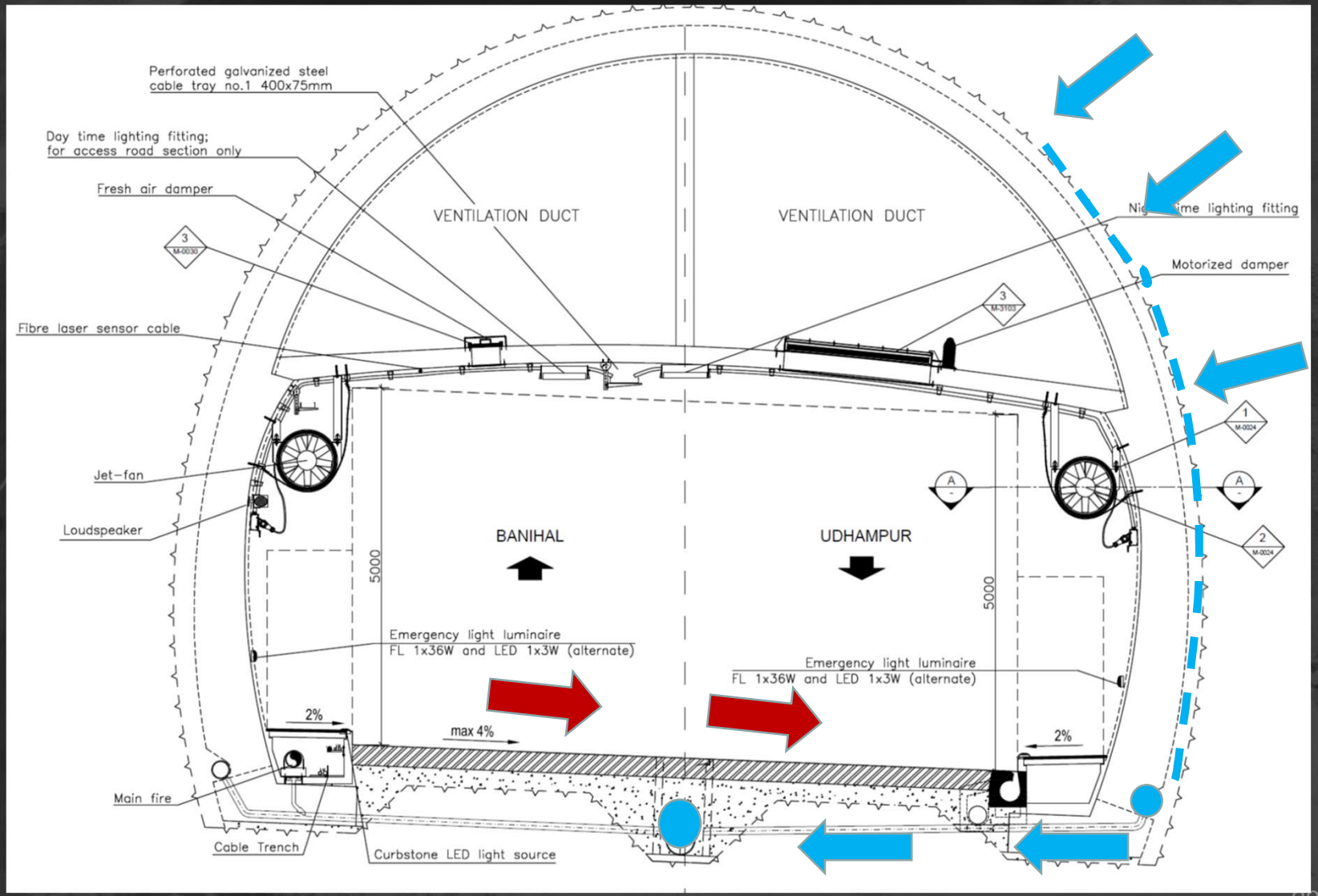
L'impianto idrico antincendio deve essere dotato di:

- Idranti **UNI 45** con relativo corredo di tubazione flessibile da 20m e lancia erogatrice. Gli idranti devono essere previsti nelle stazioni di emergenza.
- Idranti **UNI 70** con relativo corredo di tubazione flessibile da 20m e lancia erogatrice. Gli idranti devono essere previsti ai due imbocchi della galleria e nelle piazzole di sosta.
- **Attacchi di mandata per autopompa** agli imbocchi delle galleria. Gli attacchi di immissione devono avere diametro DN 70.

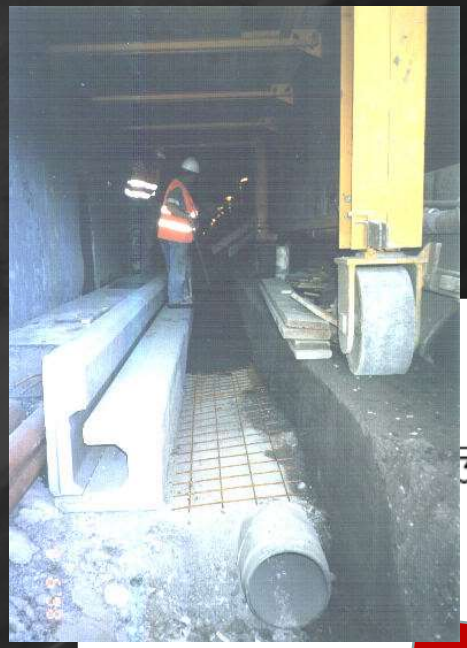
Road tunnel:portali termografici

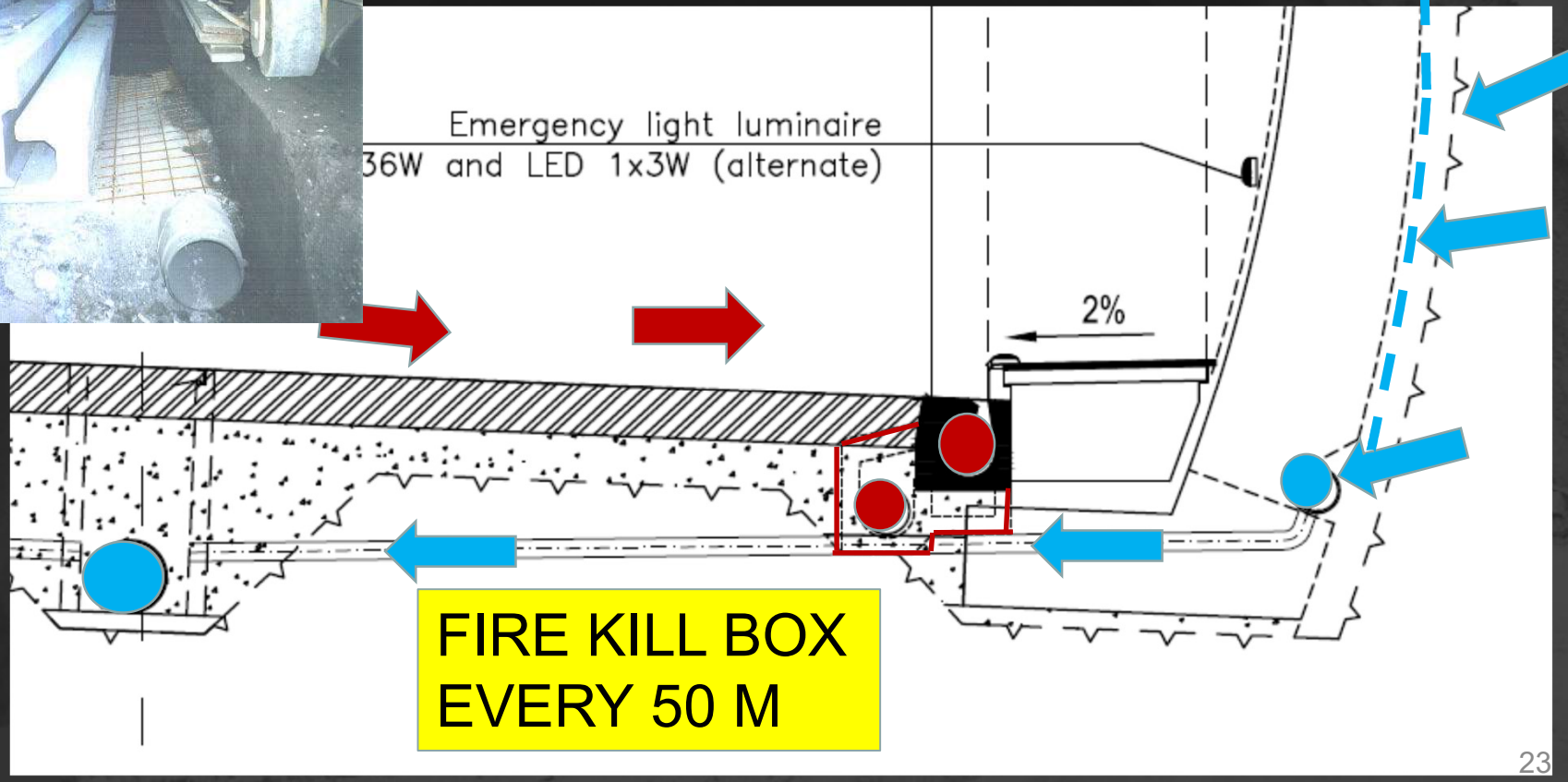


Road tunnel: water management



Road tunnel: water management

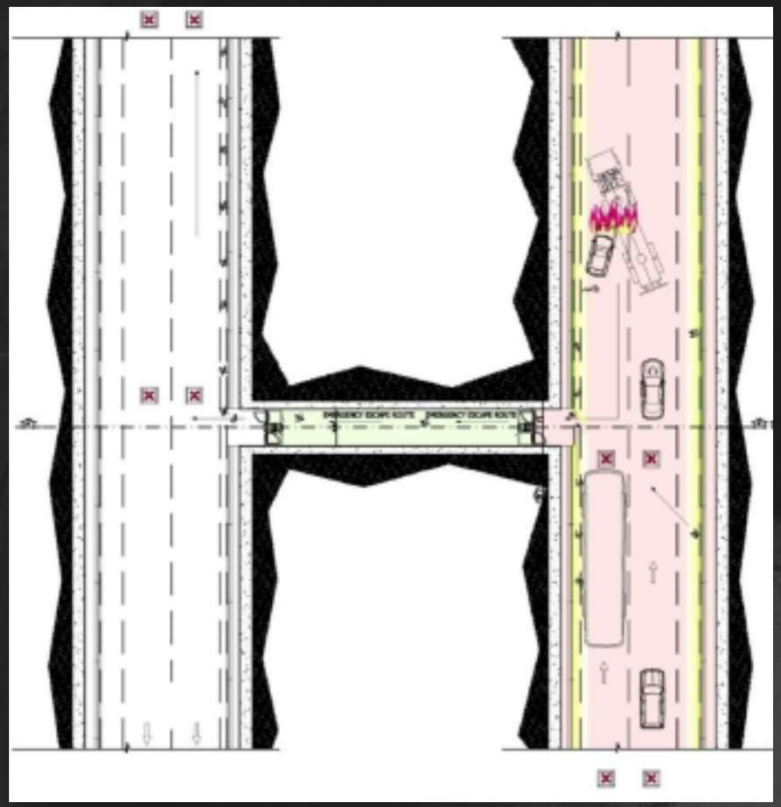




Road tunnel: escape way

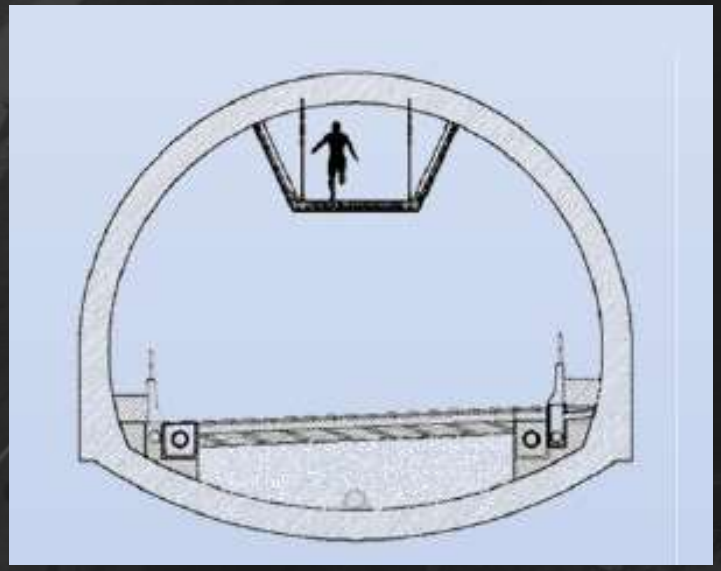
Lateral window
Escape tunnel
Twin tube tunnel
Internal escape

Road tunnel: escape way



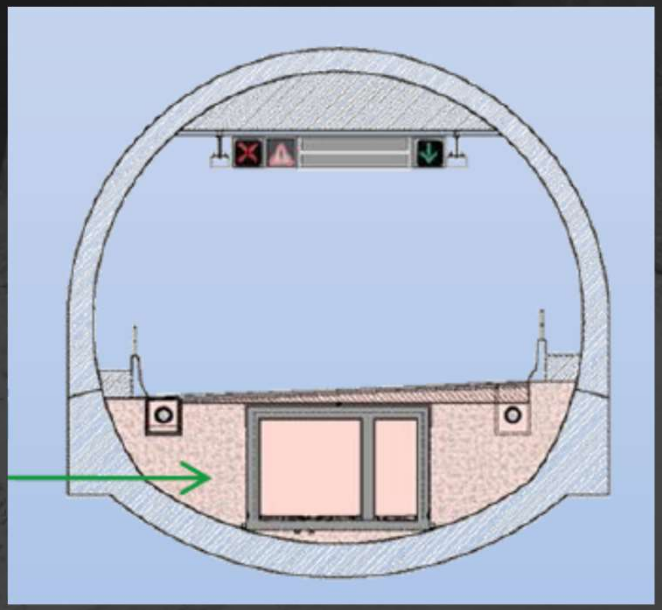
Road tunnel

Internal escape way (existing tunnel)

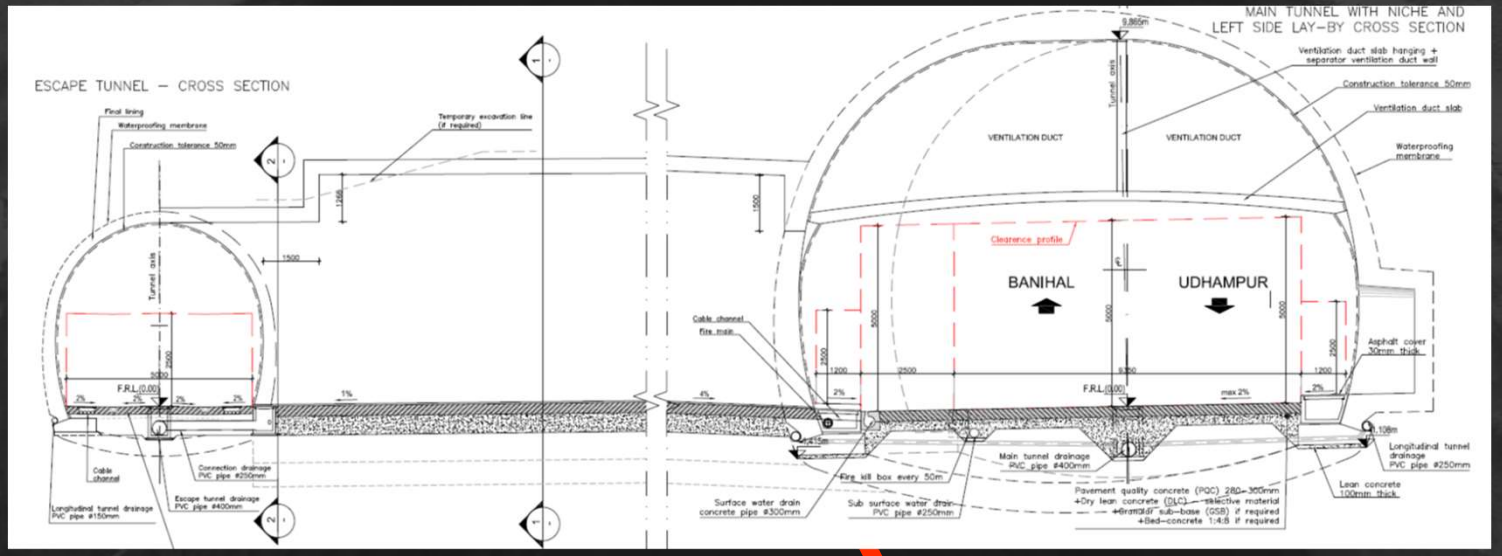


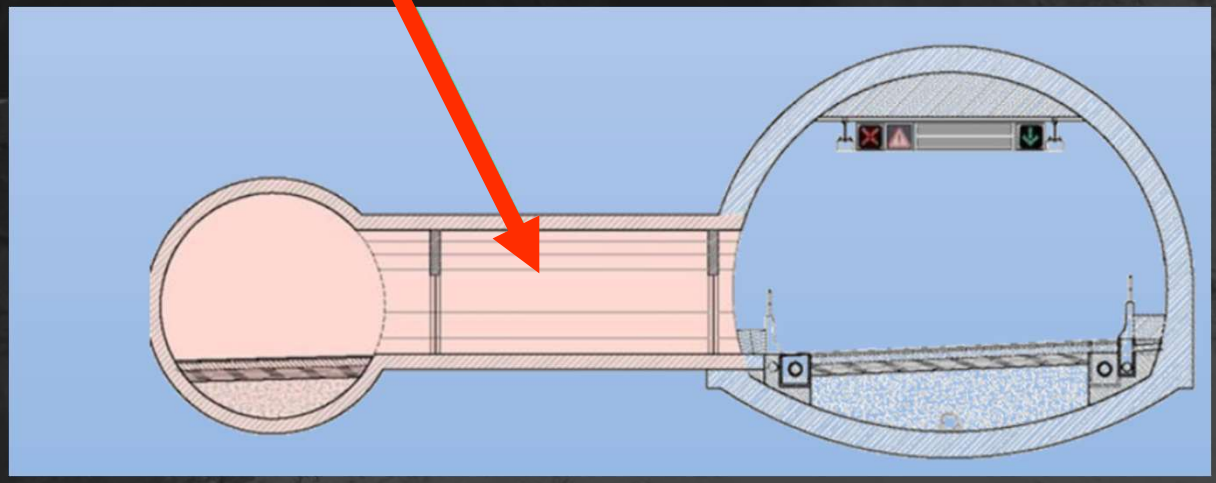
Suspended
escape way

Under
platform
escape way



Road tunnel: escape tunnel

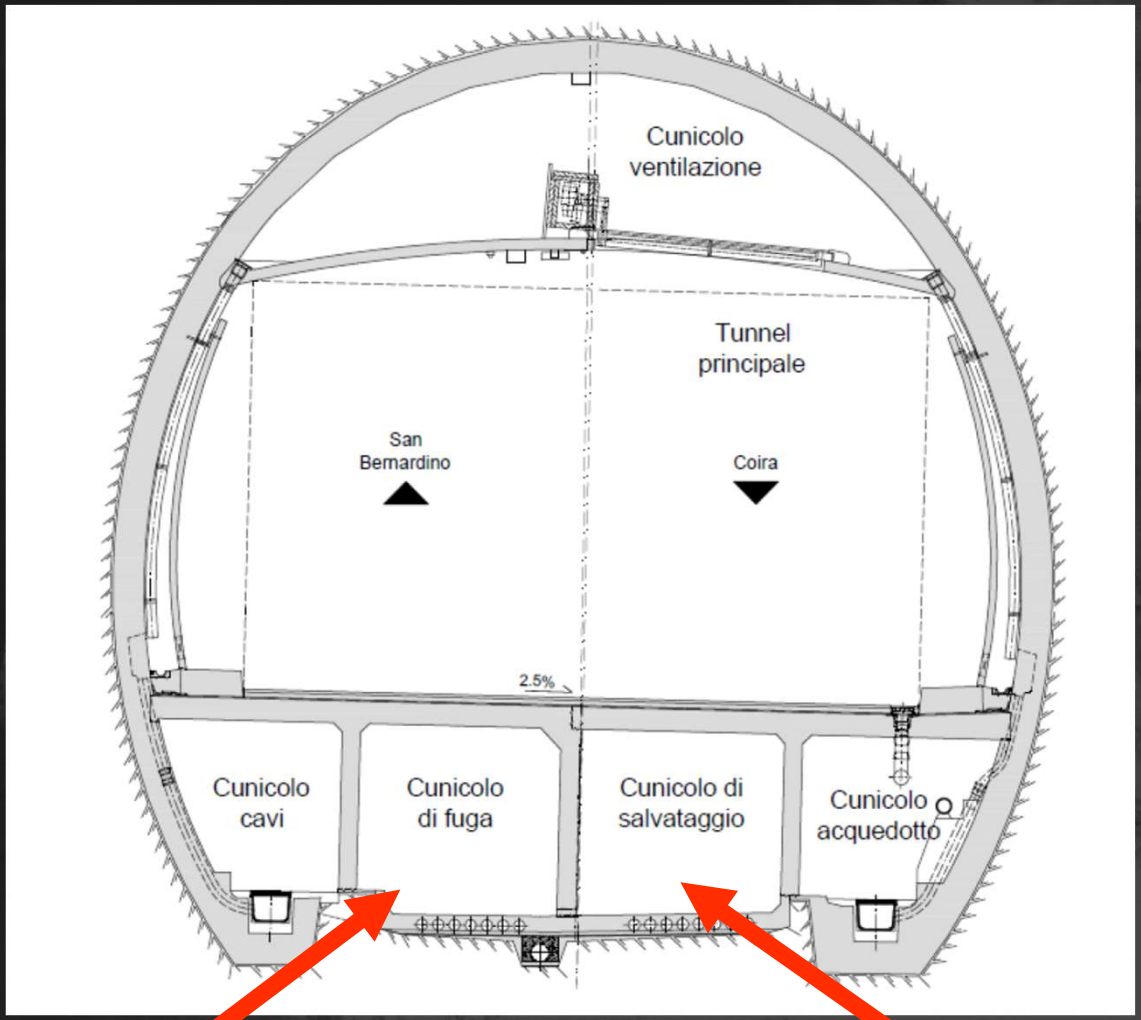




Road tunnel: escape tunnel

Tunnel
San
Bernardino

CH

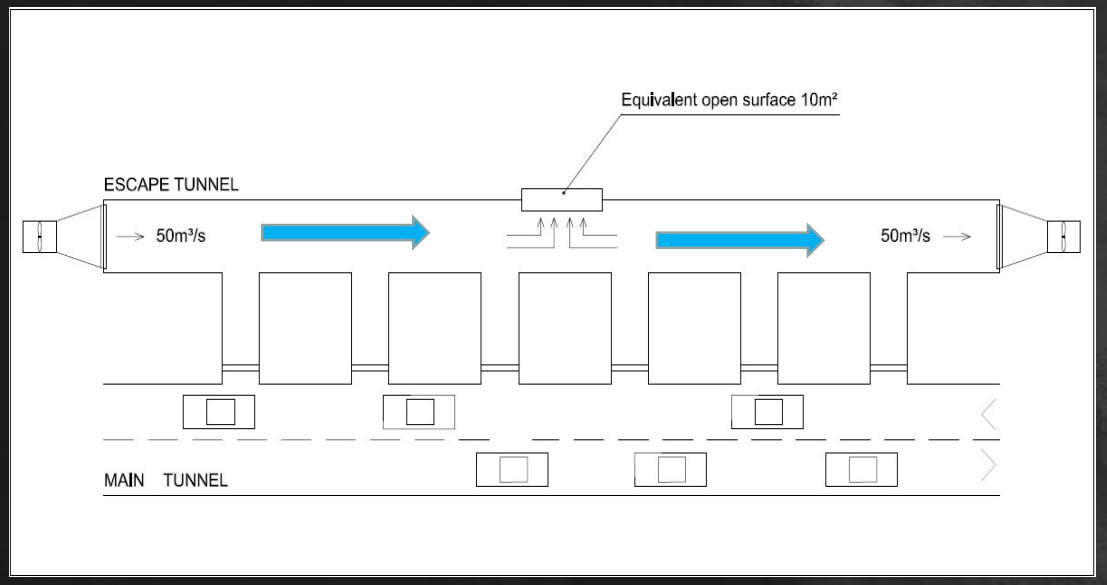


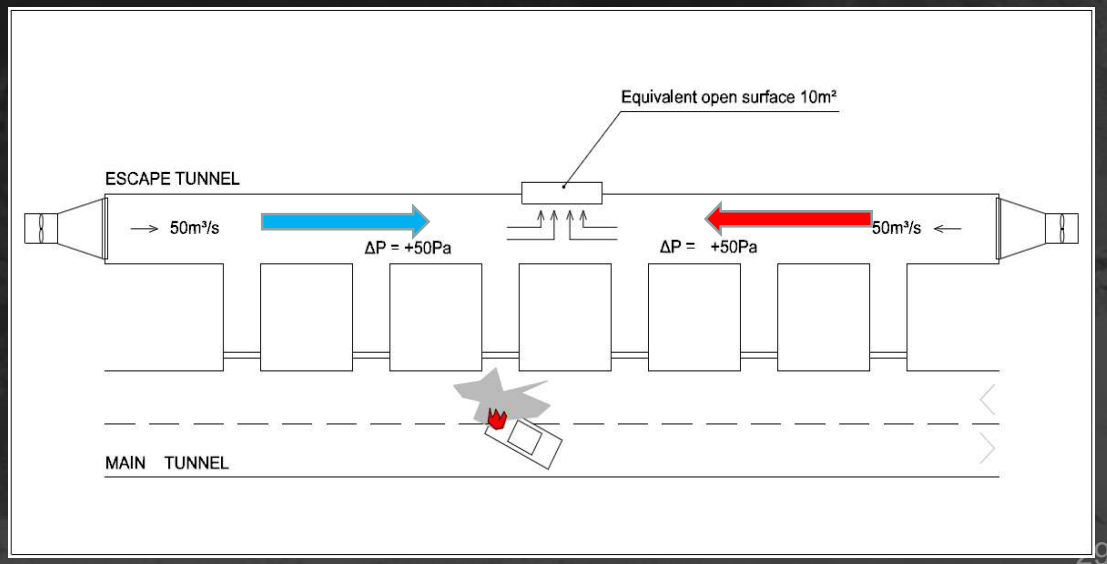
Escape tunnel

Rescue tunnel

Road tunnel: ventilation

Safe places always over pressure





Railway tunnel

Le procedure di sicurezza prevedono che, in caso d'incidente all'interno del tunnel, il treno coinvoltocerchi di proseguire la sua marcia verso l'area disicurezza più vicina (treni viaggiatori, merci o AF).

Mezzi di prevenzioni incendi sul treno

Limitazione carico di incendio sui treni

Railway tunnel

STANDARDS

1. UIC 779-9 International Union of Railways code - Safety in Railway Tunnels
2. NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems
3. NFPA 502: Standard for Road Tunnels, Bridges, and Other Limited Access Highways
4. PIARC 2012 - Road Tunnels: Vehicle Emissions and Air Demand for Ventilation
5. US EPA document - Control of Emissions of Air Pollution from Locomotive
6. SUBWAY ENVIRONMENTAL DESIGN HANDBOOK, VOLUME I: Principles and Applications, Second Edition, United States Department of Transportation.
7. CETU. Dossier pilote des tunnels équipements – Ventilation. Centre d'études des tunnels, November, 2003.

Railway tunnel

SCENARIO'S

- **Congested operations**: fresh air requirement for the **dilution of the pollutant** emissions considering a train stopped in the tunnel with engine idle, in order to keep acceptable air quality for the users.
- **Emergency operations**: definition of the ventilation system requirement when a **train on fire** is forced to stop in the tunnel, to assure a safety passenger evacuation.

Railway tunnel

DATA EXAMPLE FROM INDIA

MAXIMUM TRAIN LENGTH FOR GOODS	724	m
MAXIMUM TRAIN LENGTH FOR PASSENGER	690	m
ROLLING STOCK TYPE	A	SEE TSI SRT 2014
TRACTION	ELECTRIC	
PASSENGER AMOUNT PER TRAIN	1800	EACH
FIRE LOAD	40	MW

Tipo di frenatura	Lunghezza massima in metri
Frenatura continua tipo viaggiatori Frenatura continua mista Frenatura a mano Frenatura parzialmente continua	660
Frenatura continua tipo merci	1000

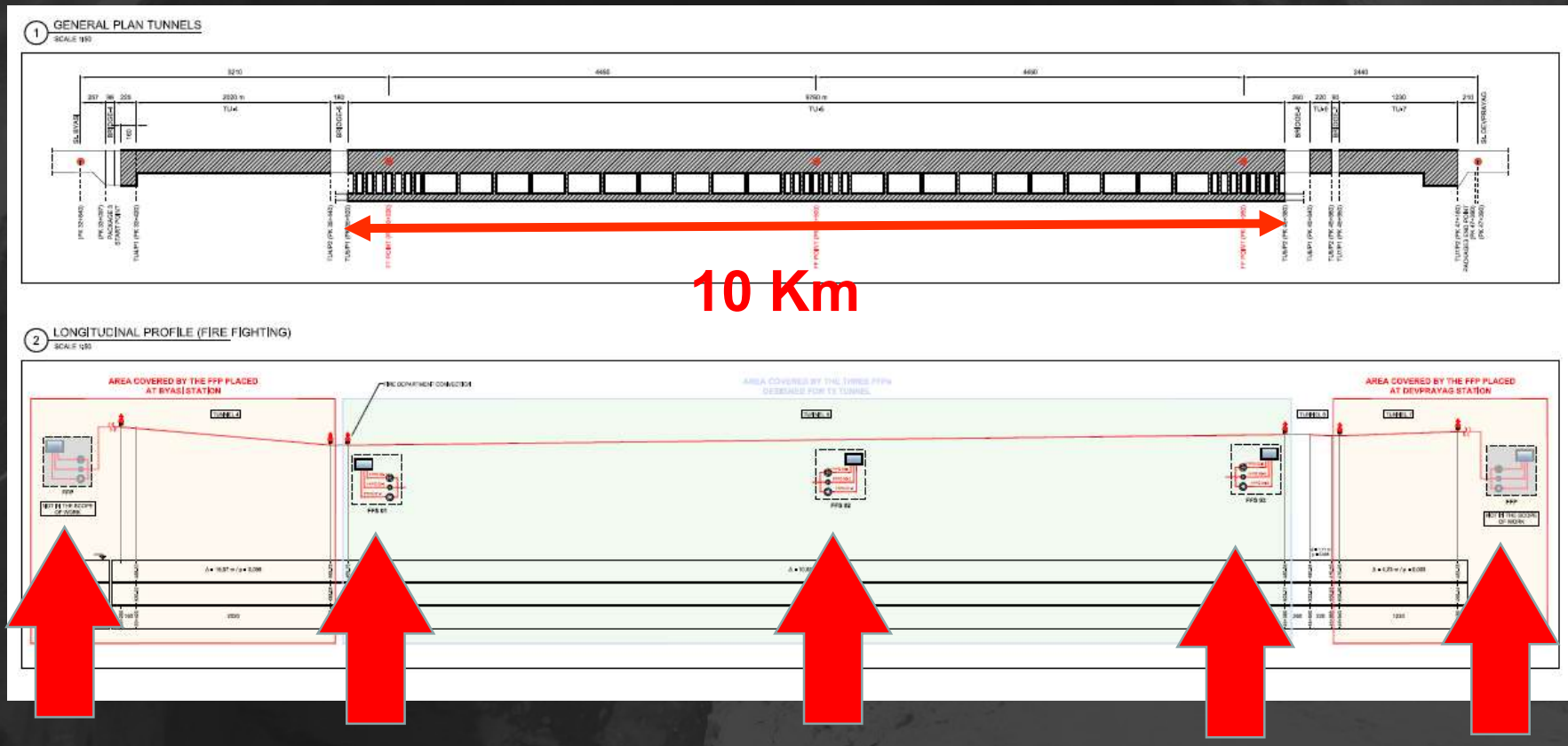
Railway tunnel Congestion operation

Limit Emission Values:
CO: 70 ppm
NOx: 5 ppm
Dry Particle: 0,007 m^-1
Temperature: 5 degree C rise

- Stationary Maintanance Vehicle (Unimog)
- Diesel Loco Operation

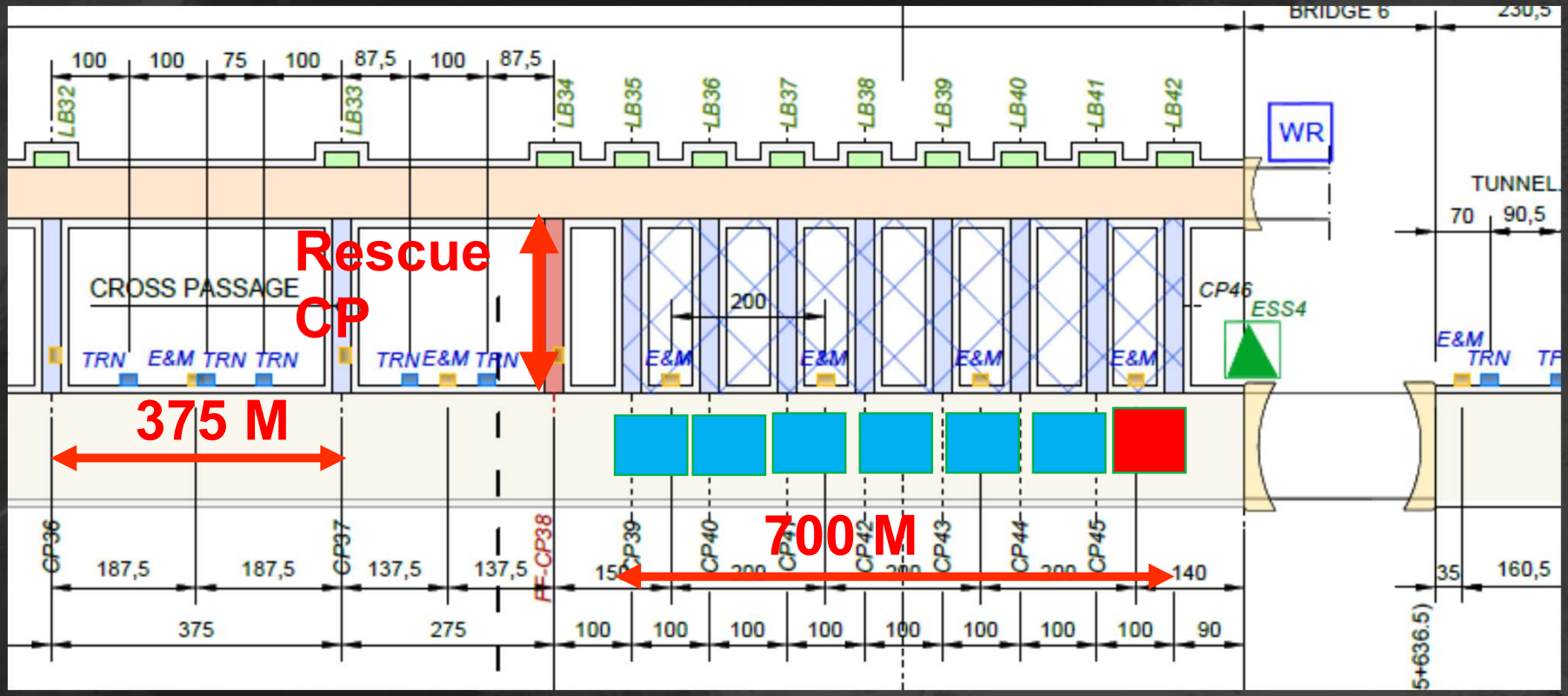
Railway tunnel Emergency operation

SCHEMATIC PLAN



FFP FIRE FIGHTING POINT D MAX 5000 M

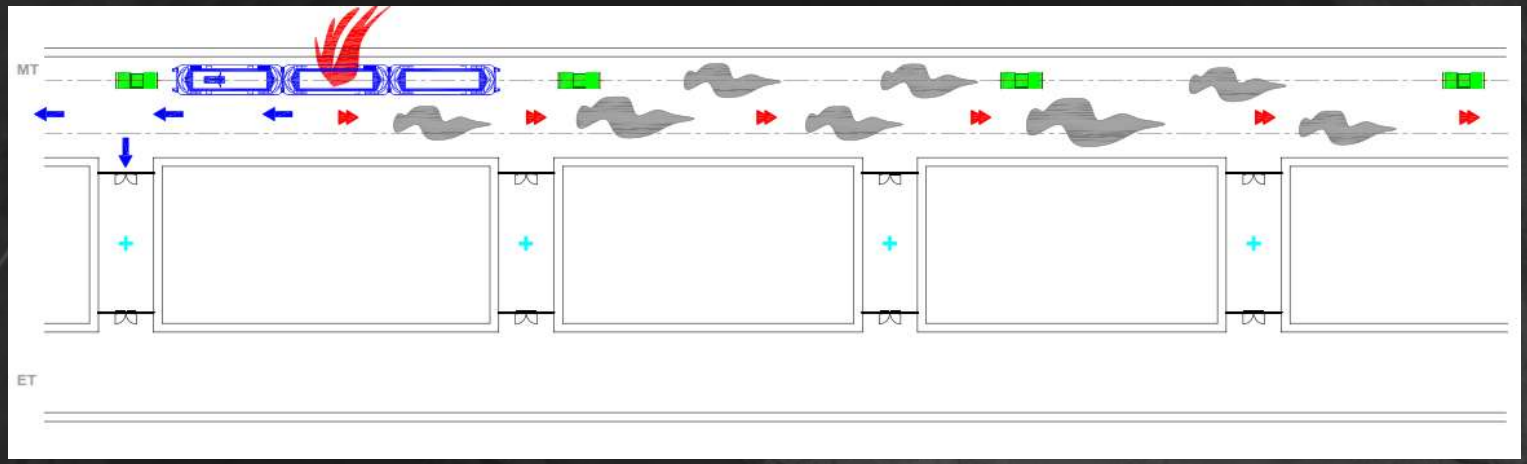
Railway tunnel fire fighting point detail



Railway tunnel Emergency operation

SCENARIOS FOR MT

Scenario 1



ESCAPE DIRECTION

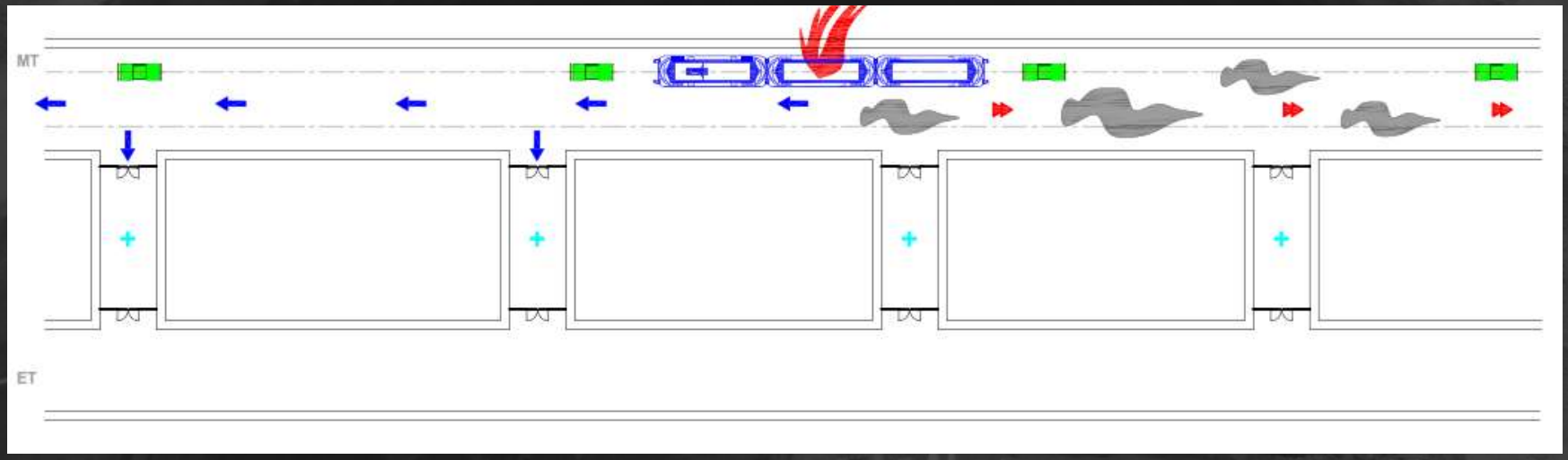
SMOKE DIRECTION

JET FAN

Railway tunnel Emergency operation

SCENARIOS FOR MT

Scenario 2



ESCAPE DIRECTION

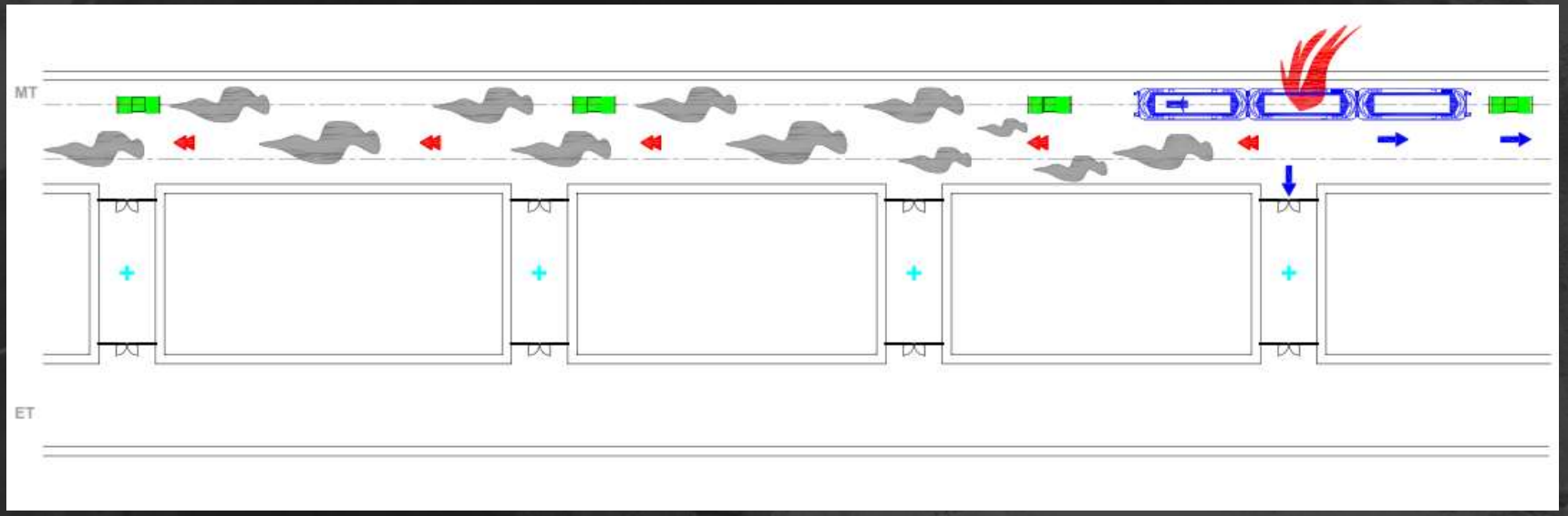
SMOKE DIRECTION

JET FAN

Railway tunnel Emergency operation

SCENARIOS FOR MT

Scenario 3



Railway tunnel Emergency operation

SCENARIOS FOR MT