

Operational experience from the Schipholtunnel systems

C.R. Uijl

(operational) tunnel manager



previous projects

- advisor O&M projects abroad
- (operational) tunnel manager dutch tunnels
- maintenance manager Westerscheldetunnel
- offshore maintenance manager
- marine engineer merchant navy



Schiphol Airport manages two tunnel systems, namely:

Kaagbaan tunnel

(freight traffic tunnel under a runway and two taxi ways)

Buitenveldert tunnel system

(public transport, general traffic and moped and bicycles tunnel under a runway and a taxi way)



*both tunnels are currently being renovated

“Existing tunnels must meet the requirements of the Warvw, including the safety standard, before 1 May 2019.”

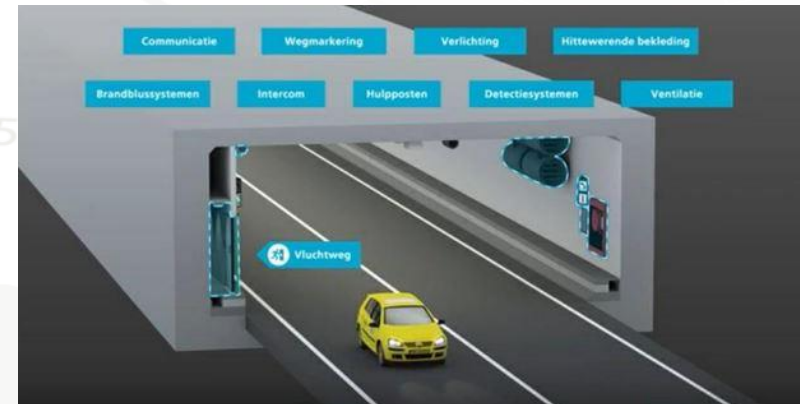
(Warvw = supplementary rules for safety, road tunnels)

For this reason, both the Buitenveldert Tunnel System (BVTs) and the Kaagbaan tunnel (KBT) at Schiphol Airport are currently being renovated to meet the requirements set in the Warvw.

The Kaagbaan tunnel

Kaagbaan tunnel is used in both directions for:

- freight transports
- kerosene transports (tankers)
- luggage transport (luggage dollies)
- crew transport
- special transports of towing / pushback tractors
- emergency services

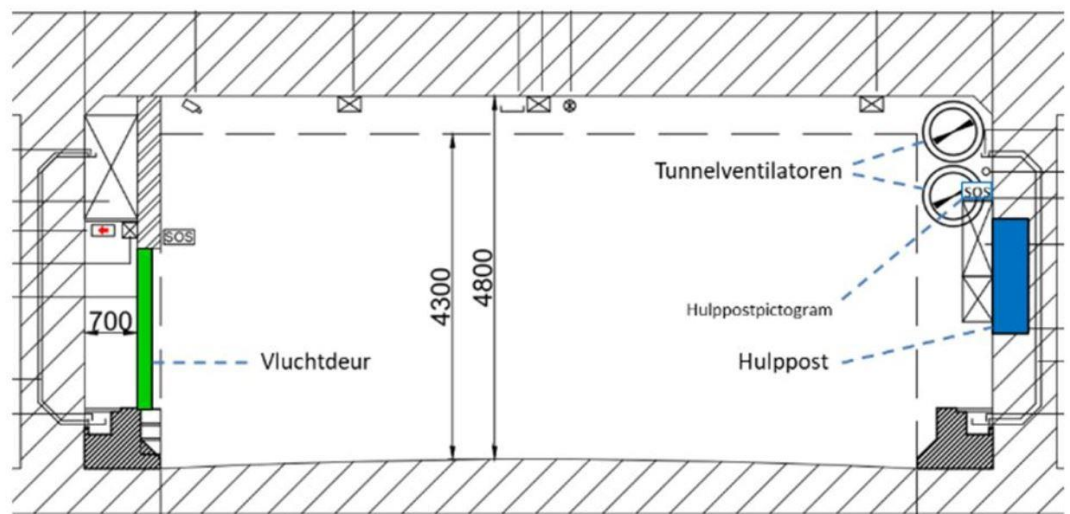


if the tunnel is not available, the Kaagbaan runway must be taken out of operation to be able to carry out the above-mentioned transports.

The Kaagbaan tunnel

Specs:

- located on airside
- cut & cover tunnel - (*wall-roof method*)
- one tube, two lanes - (*bi-directional traffic flow*)
- length = 550 mtrs.
- width = 13 mtrs.



The Buitenveldert tunnel system

The tunnel system is used for:

- emergency services
- public transport
- catering transports
- as a route to long term parking
- hotel shuttle buses
- local traffic

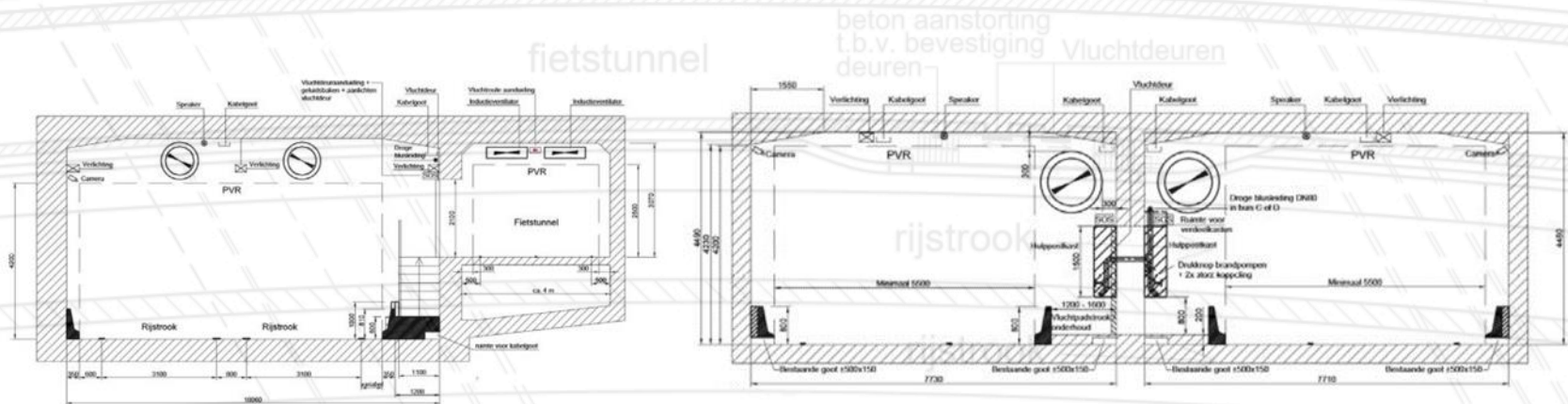


the availability of the tunnel must be high, especially the Southbound direction is of great importance for emergency services, public transport and catering transports

The Buitenveldert tunnel system

Specs:

- Located on landside
- Cut & Cover tunnel
- Four tubes, tube A – 2 lanes, tube B – 1 lane, tube C – 1 lane, tube D – 1 lane
- L ~500 mtrs.



tube A

/ tube B

tube C

/

tube D

Situation after renovation



a further focus on the Buitenveldert tunnel system

the renovation of the BVTs means the installation or the change of:

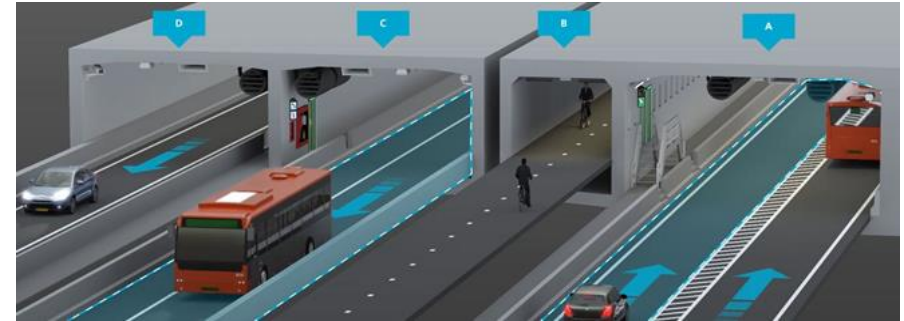
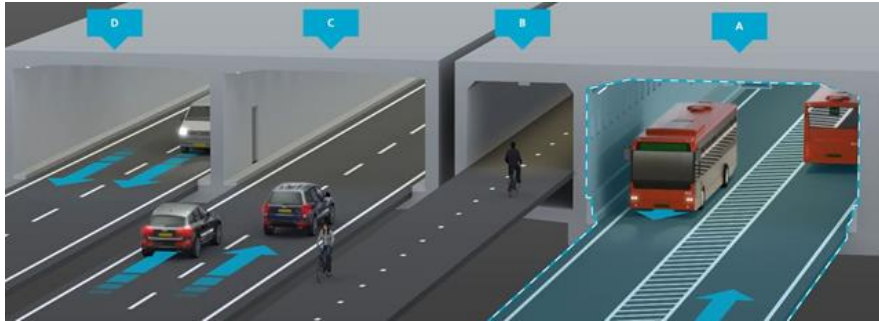
tunnel technical installations

- tunnel control room (TCR)
- tunnel ventilation
- tunnel lighting
- fire fighting system
- cctv
- emergency telephones
- pa system
- sds
- Signs
- possibility of reversing driving direction tube C

construction technical changes

- firewater storage tank
- escape path barrier
- emergency exits
(restrictions due to the above runway)
- safety panels with fire fighting appliances
(extinguisher and storz couplings 2x)
- reducing the number of lanes in tube C & D
- fireproofing
- connection to new road configuration

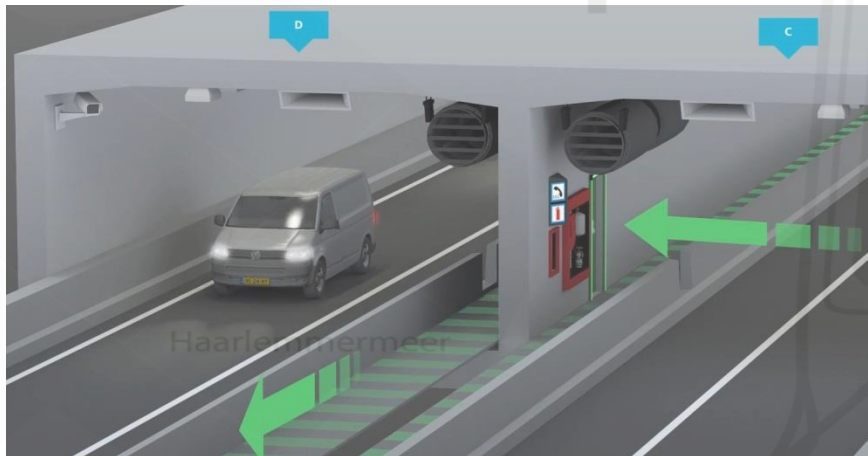
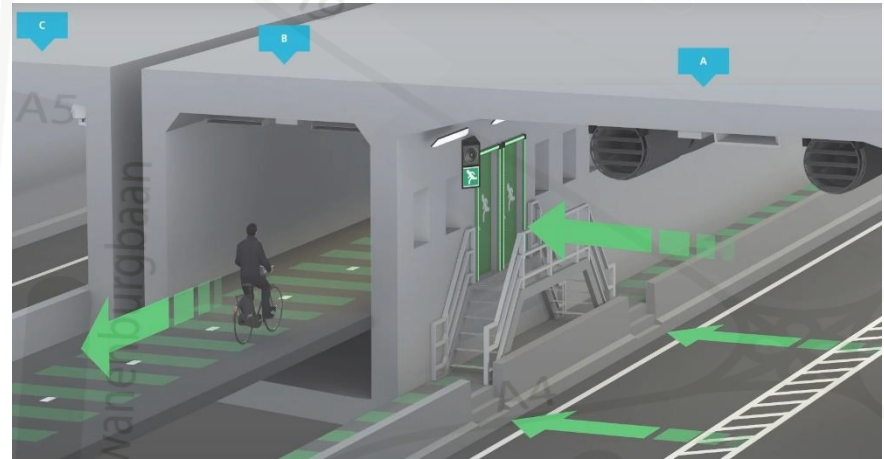
The Buitenveldert tunnel system



before renovation			after renovation	
<u>A-tube</u>	2 lanes	lane 1 - public transport southbound lane 2 - public transport northbound	2 lanes	lane 1 - general traffic northbound lane 2 - public transport northbound
<u>B-tube</u>	1 lane	bicycles/ mopeds (opposite driving directions)	1 lane	bicycles/ mopeds (opposite driving directions)
<u>C-tube</u>	2 lanes	lane 1 - general transport northbound lane 2 - general transport northbound	1 lane	reversible, standard southbound public transport
<u>D-tube</u>	2 lanes	lane 1 - general transport southbound lane 2 - general transport southbound	1 lane	lane 1 - general traffic southbound

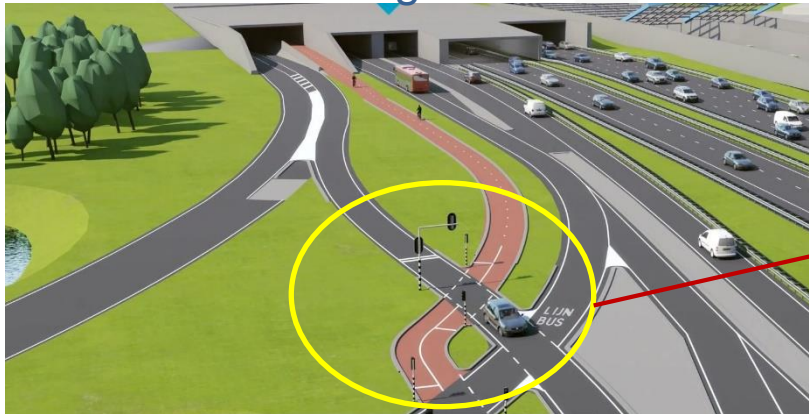
tube A – halfway through the tunnel
emergency exit (2 sliding doors)

in case of emergency escape through
the tube B



at 1/3 and at 2/3 of the tunnel length
there is an emergency exit to the other
Tube (C or D)

road configuration north side

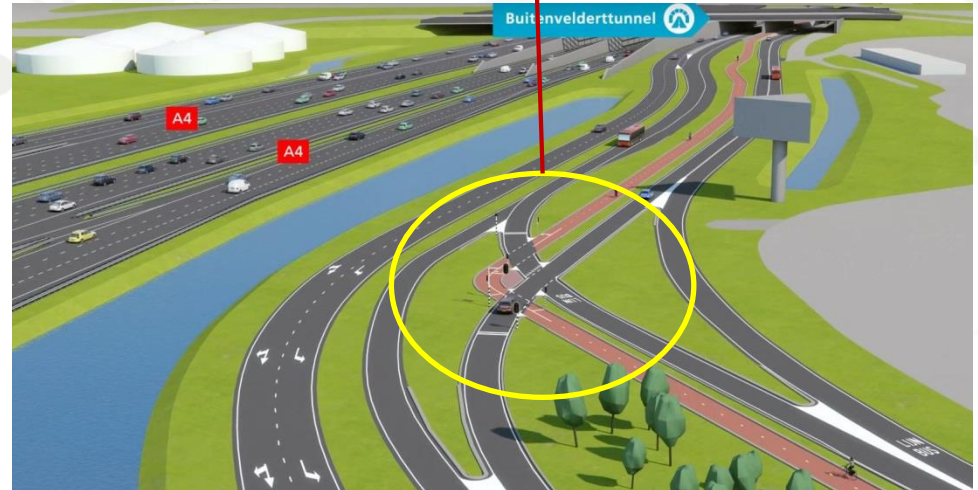


ramp metering

the calculations in the QRA show that only one bus at the time is allowed to be in a Tunnel tube.

this is why ramp metering is used.

every 30 seconds a bus is allowed to drive with a speed of 60 km/hour through the tunnel.



road configuration south side



- The tunnel tubes are being renovated in phases, in such a way that traffic is always possible in both driving directions.
- After completion of the renovation, the Buitenveldert tunnel system will meet the requirements of the Warvw, including the safety standard
- After completion of the renovation, the Buitenveldert tunnel system will be assigned to be a category-E tunnel
(this means that HGV's or other trucks with dangerous goods no longer are allowed to drive through the BVTs.)
- During the renovation, the introduction of the ZE-buses takes place
(this means that it must be checked whether this has an impact on the renovation being carried out.)

“Schiphol has the ambition to contribute to the reduction of CO2 emissions and air pollution through the implementation of zero emission public transport”



How can we realize this in relation to the large number of bus passages of the Buitenveldert tunnel system?

in the context of decision making, a report is drafted by
the Instituut Fysieke Veiligheid

"Fire Safety of Electric Buses"

There are three possibilities:

- ✗ - Electrically driven buses with fuel cell (hydrogen)
- ✗ - Gas, CNG (compressed natural gas) ≥ 200 Bar, non-liquid
- ✓ - Electrically driven buses with battery packs

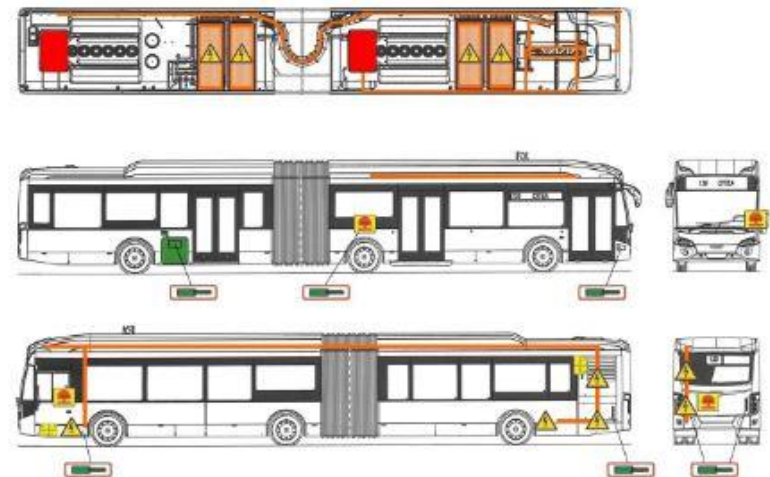
Electrically driven buses with battery packs

Pro:

- no extra risks compared to traditional fuels (diesel, petrol LPG)
- in some cases even a reduced risk (eg slower development of the fire)

Con:

- development of toxic gases in the event of fire
- eventually a higher temperature development (construction)



	650 V DC Kabels		Gasveer
	Hoogspanningscomponent		Noodstop
	Batterijmodule		24 V Accu's
	Let op: Hoogspanning nog steeds aanwezig na elektrische aandrijflijn uitschakelen.		Voorverwarmer dieseltank

The thermal runaway of the internal battery

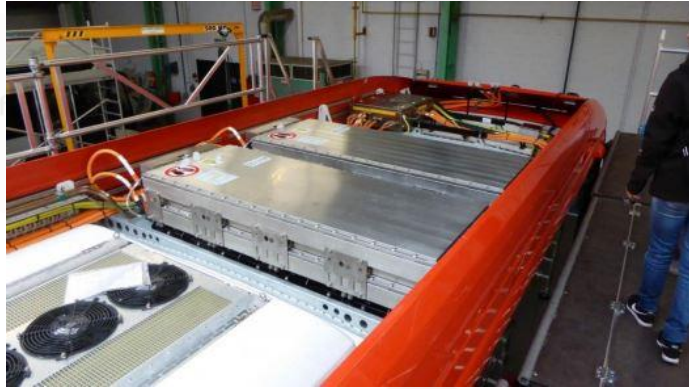
May occur:

- during the charging process
- damage caused by external damage of the battery box

when it occurs:

- slow progress (during charging or due to other technical problems).
- due to external damage, it is possible that the heating occurs more quickly.





safety and manageability

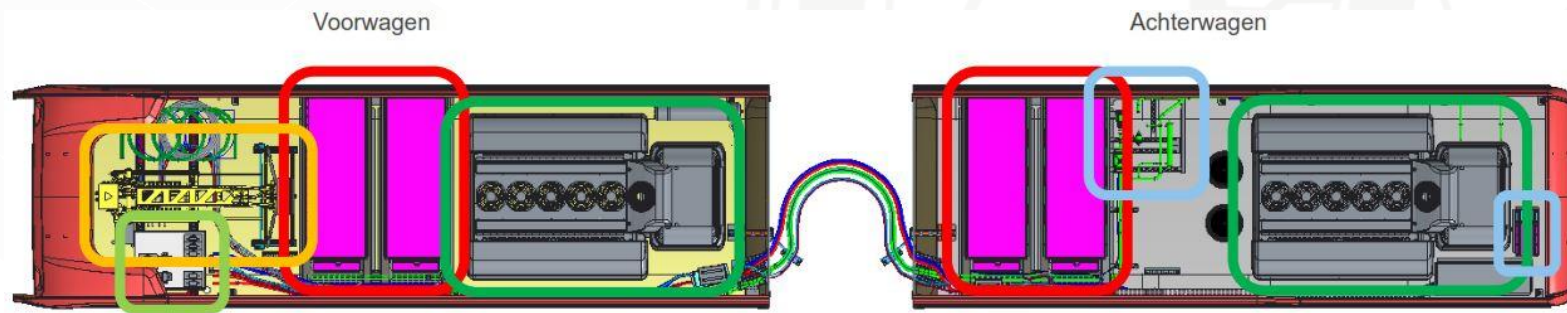
Increasing safety of the battery packs by:

- Protection against mechanical damage
- Monitoring by using Battery management system
- Conditioning of the battery packs (cooling / heating)

safety and manageability

The driver must follow a course:

- with regard to his / her responsibilities in case of an incident
(knowledge of the tunnel)
- technical knowledge of the bus
- driving techniques
- knowledge of the tunnel



At this moment we have the largest fleet of battery powered buses of Europe



Since April last year, 100 buses, powered by battery packs, have been running without serious problems

