Appendix 2.20 – The Netherlands – The Hague – Sytwende Tunnel complex

1. SUMMARY – AN URBAN MULTIMODAL TUNNEL COMPLEX

The Sytwende Tunnel complex is located in The Hague (The Netherlands). The City of The Hague has about 500,000 inhabitants, with one million in the wider "Haaglanden" Urban Community. The tunnel complex consists of three individual tunnels, Vliet Tunnel, Park Tunnel and Spoor Tunnel. It is part of Northern city ring road N14 that connects the A4 and N44 both going to Amsterdam (**Figure 1**).

Figure 1: situation of the Sytwende Tunnel Traverse

The Sytwende Tunnel complex is owned and operated by Rijkswaterstaat, which is part of the Dutch Ministry of Infrastructure and the Environment, which is responsible for the design, construction, management, operation and maintenance of the main infrastructure facilities in the Netherlands.

The N14 was originally projected as an elevated national highway in the late 1950s connecting the beach town of Scheveningen directly with Rotterdam. In the late 1990s a compromise was made and the N14 was designed as a city ring road with a maximum speed of 70 km/h and 3 tunnels to mitigate visual obstruction and noise pollution. In addition, good connections with the existing underlying road network were included in the plans.

The N14 was opened in 2003 with two tubes, each with two lanes in each direction. The Vliet Tunnel is 1100 m, the Park Tunnel is 300 m and the Spoor Tunnel is 400 m in length. Between the tunnel sections, there are junctions controlled by traffic signals. The crossroads connect the N14 with the underlying road network. The Spoor Tunnel crosses the heavy rail link between The Hague and Amsterdam.

The Vliet Tunnel has an additional tube **(figure 2)** with urban light rail vehicles and underground platforms **(figure 3).** Partly on top of the tunnel and immediately next to the tunnel structure is residential housing in the form of family homes and apartment buildings **(figures 2 and 4)**.

Figure 2: Vliet Tunnel road and rail tubes

Figure 3: Underground rail station in the Vliet Tunnel

Figure 4: Residential District on both the sides of the tunnel

1.1 MAIN CHARACTERISTIC

1.2 GEOMETRY

The Park Tunnel and Spoor Tunnel are land-based tunnels. They do not cross water and are built on site at ground level. The Vliet Tunnel is partly situated under the water table.

	Vliet Tunnel	Park Tunnel	Spoor Tunnel
Tunnel length	1.075 m	300 m	410 m
Horizontal alignment	Straight	straight	straight
Vertical alignment	Max 5%		
Speed limit	70 km/h	50 km/h	50 km/h

1.3 CROSS SECTION

The cross sections are shown **figures 5, 6 and 7** below.

	Vliet Tunnel	Park Tunnel	Spoor Tunnel
Horizontal clearance	8,4 m (2 lanes)	8,4 m (2 lanes)	8,4 m (2 lanes)
Vertical clearance	4,57 m (permitted 4 m)	4,42 m (permitted 4 m)	4,48 m (permitted 4m)
Escape route	Yes (w x h: 1,4m x 2,7m)	Yes (w x h: 2,2m x 2,4m)	No
HGV / DGV	Yes / Cat C	Yes / Cat C	Yes / Cat C

1.3.1 Vliet Tunnel (multimodal)

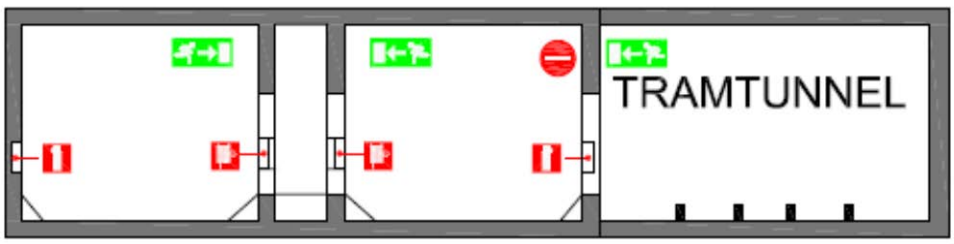

Figure 5: Cross section of the Vliet multimodal tunnel

1.3.2 Park Tunnel

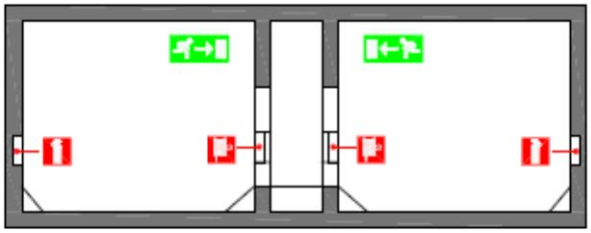

Figure 6: Cross section of the Park Tunnel

1.3.3 Spoor Tunnel

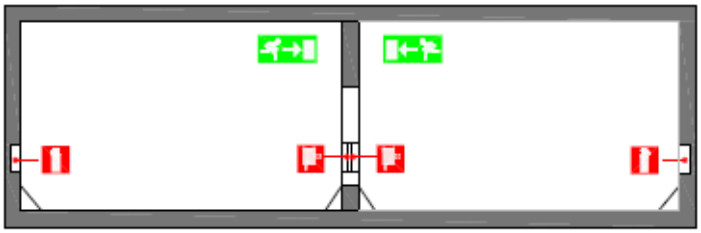

Figure 7: Cross section of the Spoor Tunnel

1.3.4 Escape route

Emergency evacuation doors between the two tubes with a spacing of about 100 m give access to the escape corridor for Vliet Tunnel and Park Tunnel and to the other tube in the Spoor Tunnel. The escape corridor is pressurised to prevent smoke from entering the corridor depending on the pressure in the main tube. The escape doors are marked with green surround LED lighting and audio messages saying, 'exit here'. The emergency corridor has variable signage guiding the evacuees back to the safe (non-incident) tube which normally serves traffic moving in the opposite driving direction to the incident tube.

The escape principle for passengers in the light rail vehicles is to exit through the underground station and platform. When the light rail vehicle has passed the station it will try to travel out of the tunnel. If this is not possible, the light rail vehicle will stop close to the evacuation doors.

The evacuation doors from the light rail tube to the road tunnel are operated by the traffic control centre of Rijkswaterstaat. The doors are locked and are released after the traffic in the non-incident tube has been cleared to avoid the danger of vehicles colliding with evacuating pedestrians.

1.4 TRAFFIC CONDITIONS, TRAFFIC SITUATION

1.4.1 Traffic conditions

- AADT (annual average daily traffic): 28.000 veh. / day,
- Hourly traffic distribution during the day.

Average Hourly traffic per direction	Direction N14	Direction A4
Between 07.00 and 19.00	1.790	1.863
Between 19.00 and 23.00	860	859
Between 23.00 and 07.00	253	285

Traffic of vehicles transporting dangerous goods is around 11 DGV / day

- DGV LF1 (flammable liquids) 805 vehicles / year,
- DGV LF2 (flammable liquids) 3168 vehicles / year or around 11 per day,
- DGV GF3 (toxic liquefied gases). These are banned but there are violations: 16 vehicles per year.

1.4.2 Traffic Signals / Congestion

Due to the close proximity of traffic lights at Monseigneur van Steelaan and Prins Bernhardlaan **(figure 8),** there are regular traffic queues inside the tunnels. These traffic queues trigger the low speed detection system that produces alerts in the control room in the event of low traffic speeds. The reduced / low speed detection system is designed for highway speeds (100 to 130 km/h). It was implemented but due to the low design speeds it was not possible to calibrate it accurately to distinguish 50 km/h flow or slower speeds.

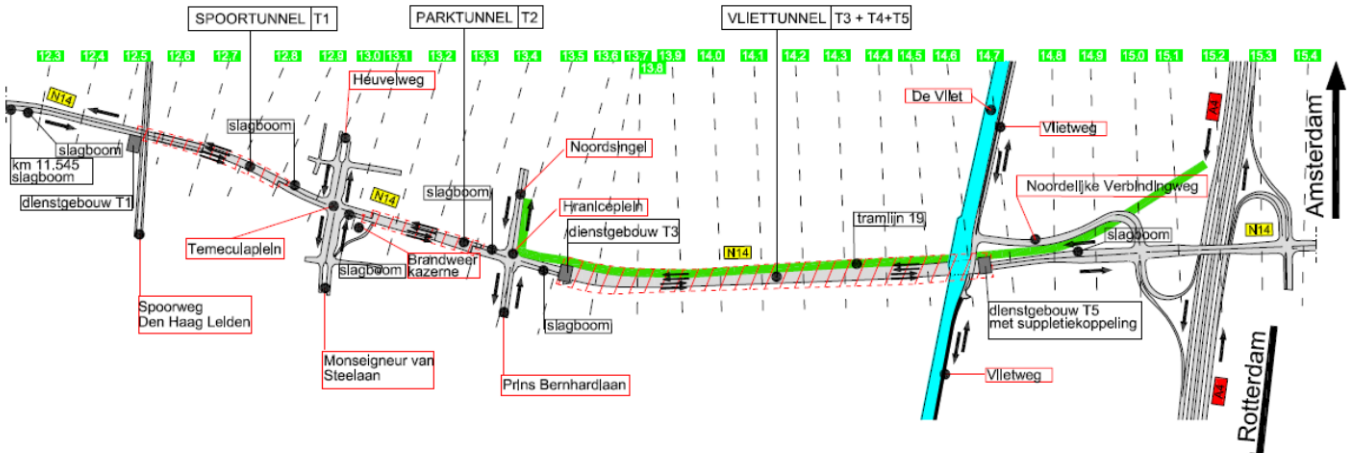

Figure 8: Layout of the succession of the three tunnels and the two main crossroads

1.5 VENTILATION

1.5.1 Ventilation system for the road tunnel

The ventilation system is a longitudinal type. There are uni-directional jet fans at the entry portal and reversible jet fans inside the tunnel. The ventilation principle is to create airflow in the direction of traffic movement. In the non-incident tube the airflow will be reversed to prevent smoke entering this tube. The evacuation routes are pressurised to avoid the smoke entering this safe zone.

1.5.2 Ventilation of the multimodal tunnel

The ventilation system of the light rail tunnel is based on the principle that the underground station has to remain free from smoke. A smoke-free station allows passengers to evacuate. Bi-directional jet fans direct the air flow to the nearest exit away from the station.

During an incident with a fire in the light rail tube, the road tunnel tube next to it will be closed as well. The air flow in the road tunnel will be in the same direction as the air flow in the light-rail tunnel.

1.6 OPERATION AND SAFETY EQUIPMENT

The three tunnels are equipped with all the usual operation and safety equipment. Particular attention has been paid to the communication with tunnel users, the traffic management and the safety and environmental conditions: detectors, CCTV, AID (automatic incident detection), loops, heat detection cables, etc. The PA (Public Address) system has messages in Dutch, English and German.

1.7 OPERATION

The Sytwende tunnel complex is operated by the Traffic Control Centre in Rhoon. This centre controls all Rijkswaterstaat owned roads in the province of Zuid Holland. This control room operates six other tunnel complexes as well and in 2015 it will also operate the A4 Delt Schiedam tunnel.

Each traffic control operator has two methods of intervention:

- During the day ITS systems (variable speed limits, commuter lanes, and variable message signs) are operated on a separate desk.

- During an incident, the neighbouring operator will assist in communication with emergency services and dispatch of service vehicles and towing / salvage and maintenance personnel. The operator deals with the incident, communicates with the people inside the tunnel complex, and also operates the SCADA system.

Each tunnel complex has a local control centre as well that can be used when the data connection from the tunnel to the control centre is not working properly or when there are availability issues at the Control Centre in Rhoon.

The SCADA system is equipped with an emergency function that automatically operates ventilation systems, closes the tube(s) to prevent more traffic from entering and illuminates the evacuation route and standard evacuation messages. Water pumps are activated to pressurise the nozzles. The emergency button also activates a ‘green wave’ in the traffic signals over the whole section between N14 and A4 allowing the motorists to safely leave the tunnel with their vehicles.

In case of an emergency, the emergency teams approach the tunnel from both sides in the direction of traffic. Only after communication with Traffic Control Centre are the emergency services allowed to drive against the normal traffic direction. This is to make sure that traffic is stopped. In the event of an emergency with the possibility of smoke and or fire, the emergency services will enter the tunnel through the safe (non-incident) tube. Before entering, the emergency services use the emergency call box at the tunnel portal to receive an update from traffic control and receive advice as to which emergency door to use.

2. PARTICULARITIES OF THE MULTIMODAL TUNNEL

The light rail tunnel is operated by the control room of the Haagsche Tram Maatschappij (HTM), the local public transport company. In case of an emergency, the HTM control room calls the Traffic Control Centre in Rhoon who closes the tube to allow for safe evacuation.

In case of an emergency, the emergency services will drive into the road tunnel and enter the light rail tunnel through the evacuation doors.