

Appendix 2.11 - FRANCE – Paris La-Défense – tunnel « Voie des Bâtisseurs »

1. A TUNNEL WITH 50 INTERFACES

The business district of La Défense in Paris area has been created with a strict separation of flows according to the principles of the Charter of Athens⁽¹⁾: the upper space in open air is reserved for pedestrians, while traffic is in the underground.

Although remarkable, this concept raises important questions of safety for the 6 km of underground roads network own by EPADESA (Public Organisation for the Development of La Défense Seine Arche).

These different roads are classified according to their function: (1) route of transit or (2) service road.

The first class ensures a traditional function of local transit through the business district, while the second class serves the towers and buildings of the business district. The complex "Voie des Sculpteurs" – "Voie des Bâtisseurs", with a total length of about 1,500 m, serves the eastern part of the business district between Pont de Neuilly and Place de La Défense (**Figure 1**).

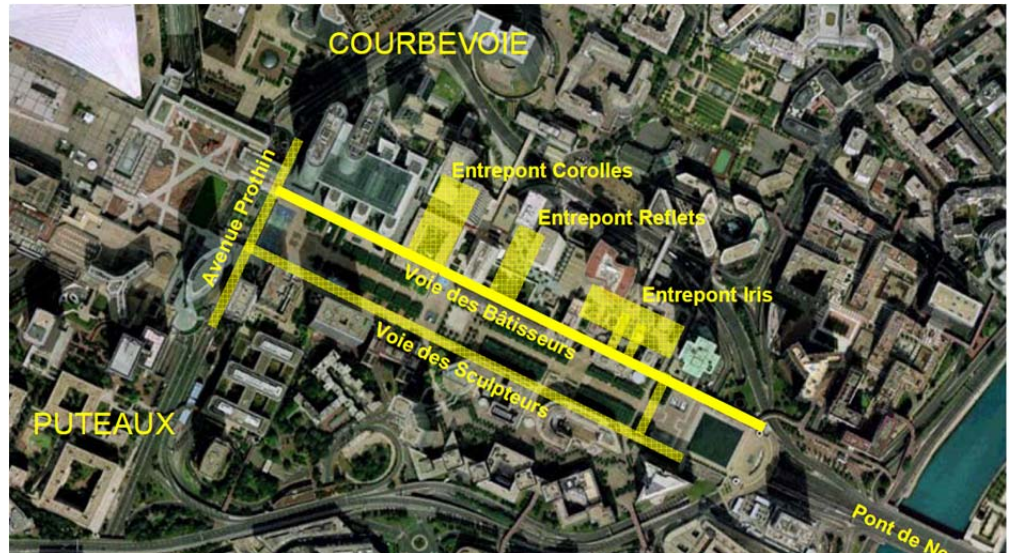


Figure 1 - situation of the “Voie des Bâtisseurs”

These roads have been operated since 1984 as a private network. In 2007, the prefect of Hauts-de-Seine decided to consider La Défense underground network as belonging to the public road system and asked to apply to the EPADESA road network the safety regulation of the public road tunnels. The projects for upgrading works and complying with the regulation are going on, as presented in §7 below.

This underground roads network is dedicated to deliveries, public transit, car parks access, etc. Its complexity is due to:

- The underground roads have many structural interfaces with neighbouring constructions,
- The activities of these buildings generate flows of delivery vehicles, collection of waste, service providers or the operation and maintenance of technical installations, as well as the users of the buildings for accessing to the underground car parks,
- The operation of the network is currently provided by three operators. Interface structures are operated by other private operators.

The Voie des Bâtisseurs (**Figure 2**), has a length of 700 m, and is operated with a one-way traffic. It serves an important number of utilities (docks for delivery of the towers, inter-company restaurants, parking spaces, technical facilities, etc.), through numerous interfaces including three car decks: Iris, Reflets and Corolles.

This road and its cars deck also allows access and the intervention of emergency services in the high-rise towers located in this area of the business district: areas of parking for the emergency services, direct access to the control rooms of the towers, and to the hydrants of the firefighting facilities.

The “Voie des Bâtisseurs” and the “Voie des Sculpteurs” have a strategic and essential function for the activity of La Défense business district. They have many interfaces related to those particular functions. Globally the

⁽¹⁾ Charter of Athens: this chart results from the works of the International Congresses for Modern Architecture. It has been written by Le Corbusier in the 30s, for the concept and the development of new cities.

complex “Bâtisseurs-Sculpteurs” present more than 50 interfaces with third-party premises, interfaces which are as much stakes for safety as complexity for operation (**Figure 3**).

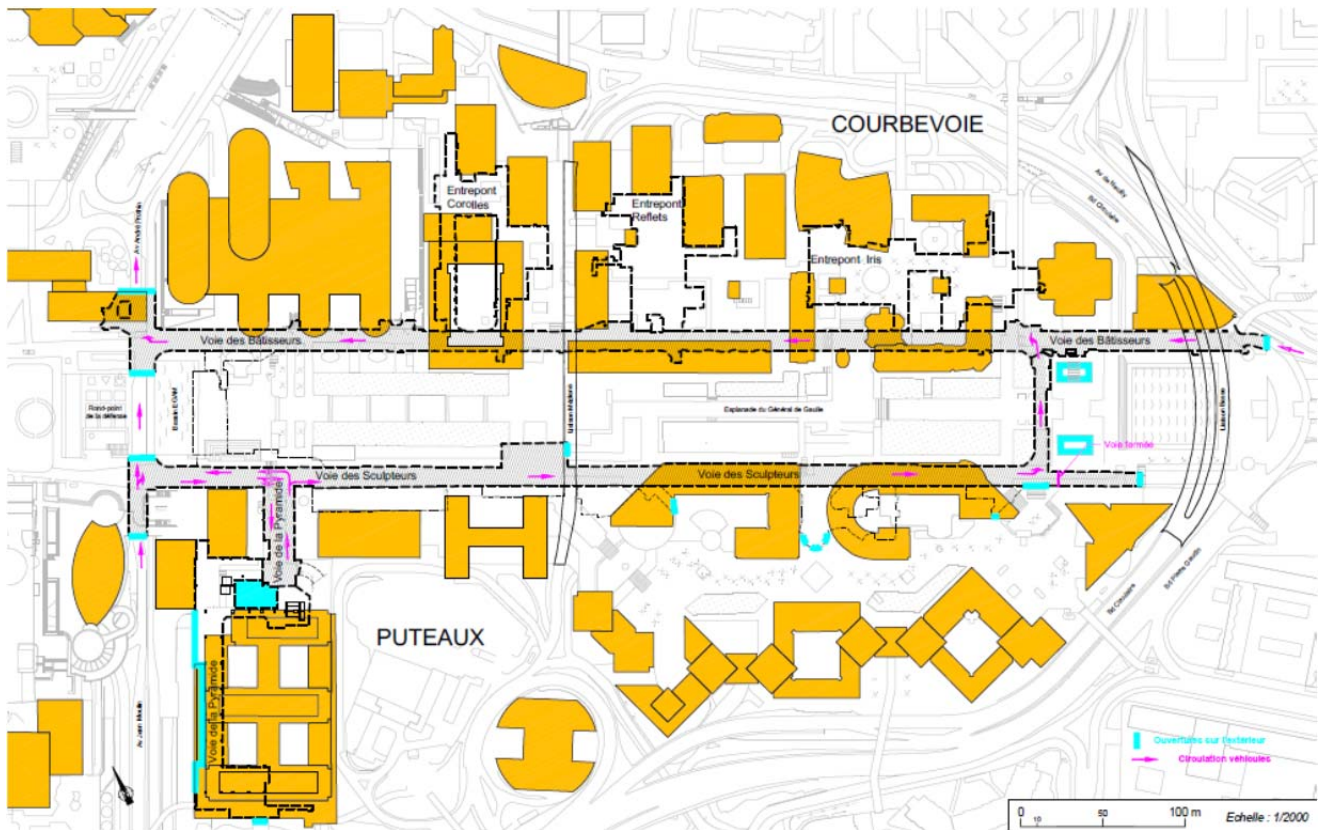


Figure 2 : general plan of «Voie des Bâtisseurs – Voie des Sculpteurs » roads network

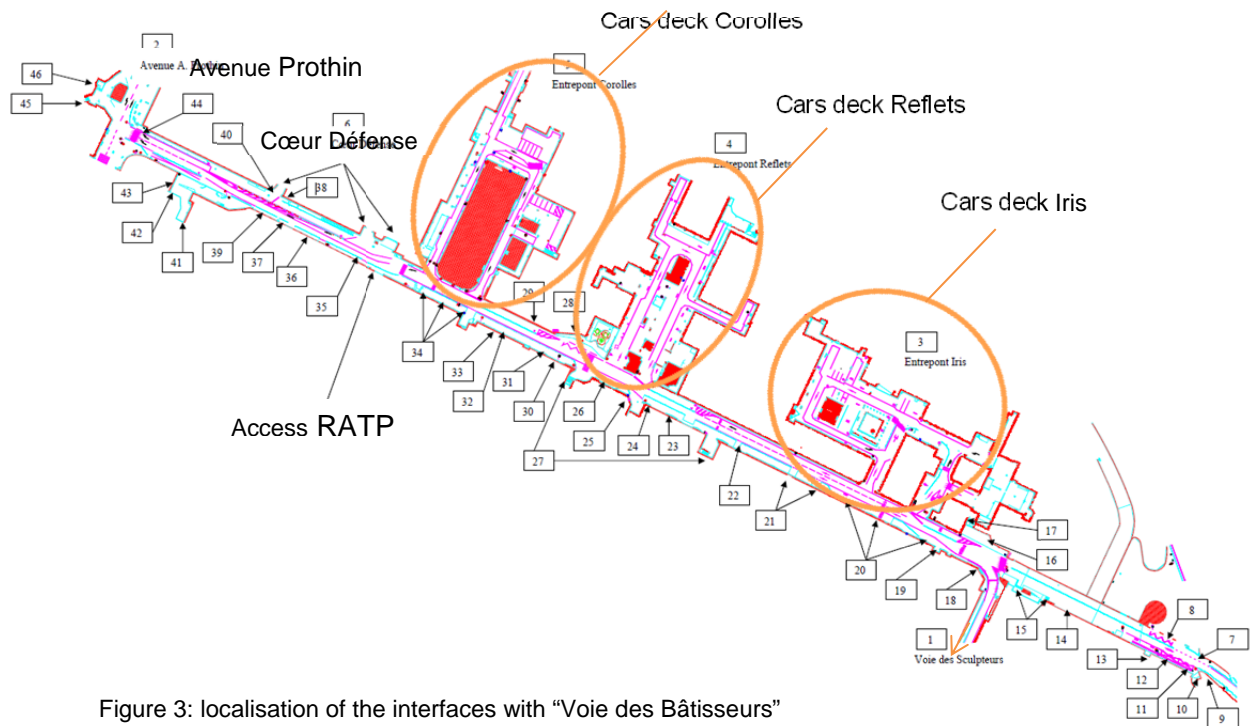


Figure 3: localisation of the interfaces with “Voie des Bâtisseurs”

2. MAIN CHARACTERISTICS « VOIE DES BÂTISSEURS »

2.1 GEOMETRY

- Tunnel length : 700 m,
- Horizontal alignment : straight,
- Vertical alignment: average gradient of 2.7% climbing from Pont de Neuilly to Avenue A. Prothin.

2.2 REGULAR CROSS SECTION

- The overall width between tunnel walls is 11.8 m.
- This width is variable according to the local conditions and the structures of the buildings,
- A walkway on the right-hand side of 0.80 m width,
- 2 traffic lanes of 3.50 m width,
- A shoulder on the left-hand side, likely to host parking areas 4.00 m of width.



Figure 4 : entrance portal - Voie des Bâtisseurs

3. TRAFFIC CONDITIONS, BREAKDOWNS & ACCIDENTS

3.1 TRAFFIC CONDITIONS

- The AADT (Average Annual Daily Traffic) is estimated at 3,500 veh/d. The peak hour traffic volume is about 300 veh/h, between 8h and 9h in the morning and 18h and 19h in the evening that is a commuters traffic from home to the workplace,
- Traffic breakdown shows: 16.20% of trucks and 20% of bikes and scooters. The high traffic volume of trucks results from the supplying function of Voie des Bâtisseurs.
- Access is forbidden for hazardous goods.

Congestion sometimes occurs due to the presence of traffic lights at the junction with avenue A. Prothin.

3.2 ACCIDENTS & FIRES

- Between 1996 and 2009 22 accidents and 15 fires occurred inside Voie des Bâtisseurs and the car decks.
- 100% of the accidents occurred inside Voie des Bâtisseurs, while only 7% of the fires occurred inside this road.
- 41% of accidents involve vehicles exceeding the vertical clearance, the rest being traffic accidents. 54% of accidents involve trucks, which is explained by their significant percentage in traffic.

3.3 ESCAPE ROUTES

There are 5 emergency exits linking to the outside on the Esplanade Charles de Gaulle. The average spacing between two exits is 150 m. They all have an airlock of 5 m² which is fire-rated for two hours.

Two stairs, close to the portals, also enable access to the Esplanade (figure n°5).



Figure 5: escape exit on the Iris square

4. SAFETY AND OPERATIONAL EQUIPMENT

The main operating and safety equipment is shown in **Figure 6** below.

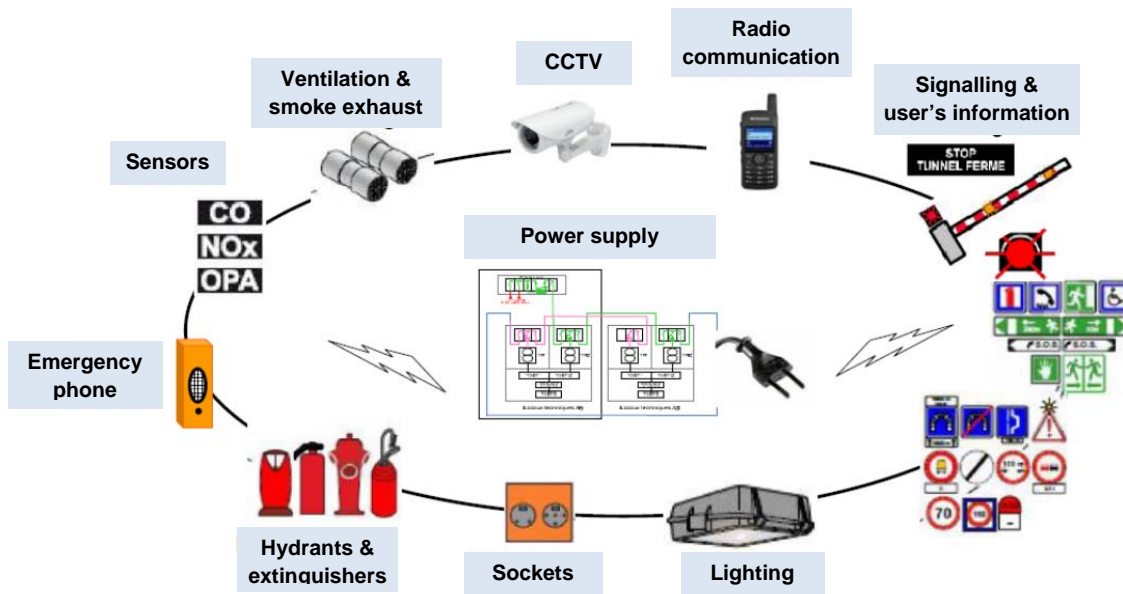


Figure 6 : main safety and operational equipment

5. PARTICULARITIES DUE TO THE NUMEROUS INTERFACES

Voie des Bâtisseurs has interfaces with several types of facilities:

- Motorway A14, operated by DiRIF,
- Cars parks, operated by SEPADEF,
- Metro station "Esplanade" operated by RATP,
- High-rise towers, under the responsibility of their owners. They have a control room with operators educated and trained for fire safety,
- Malls, retail units, hotels under the responsibility of their management,
- Apartment buildings, under the responsibility of their property managers,
- Three car decks for deliveries and assuring links between multiple interfaces.

5.1 INTERFACE WITH « VOIE DES SCULPTEURS »

Voie des Bâtisseurs and Voie des Sculpteurs are independent from a ventilation point of view as they are separated by large open-air sections.

5.2 CAR DECKS

Three underground car decks assure the local services and accesses.

- Iris: serves three towers (Manhattan and CB21 with each 80,000 m² space, approximately 10,000 people, and Iris Tower), as well as two apartment buildings (Neuilly Défense with 127 flats, and Manhattan Square with 275 flats),
- Reflets: serves three towers (CGI and Aurore with each 28,000 m² space and Praetorium Tower with 10,000m²), as well as two apartment buildings Vision 80 (236 flats),
- Corolles: serves four towers (la Tour Blanche, Europe, Chartis with each 28,000 m² space, and Carpe Diem Tower with 44,000m²) and Résidence Lorraine (apartment building with 112 flats).

6. OPERATION – CONTROL CENTRES

6.1 CONTROL CENTRES

The current organisation is as follows:

- Operation and control of the motorway tunnel A14 is done by SAPN (Société de l’Autoroute Paris – Normandie), from the control centre of Montesson, which also operates a motorway section with a large tunnel (Saint Germain-en-Laye)
- Voie des Bâtisseurs is operated by Defacto.

This organisation is under evolution with the creation of a unique body in charge of operation and safety and the construction of a new control centre that will be in charge of the supervision of all tunnels in the La-Défense district. The coordination will also be improved with all other control rooms (car park, shopping centres, CNIT, towers, etc.).

Operators of the interfaces must take action to ensure that decisions taken and actions implemented on “Voie des Bâtisseurs” are relayed in the case of an incident. In particular, they must ensure the management of the flow and the safety of the people and users which they are responsible.

6.2 VENTILATION

The ventilation is longitudinal and has three groups of jet fans.

It should be noted, however, that the smoke exhaust is effective only if fireproof curtains isolating the car decks are closed. The implementation of smoke extraction is controlled by the operator from the control centre.

A fire-proof curtain ensures the isolation between Voie des Bâtisseurs and Voie des Sculpteurs at their eastern interface.

6.3 FIRE RISK

Fire risk has been recently reduced to the following root causes:

- Prohibiting the transport of hazardous goods (except oil deliveries carried out under specific conditions);
- Limiting the vertical size of vehicles to 3.5 m;
- Limiting vehicle weight to 19 tonnes;
- Prohibiting pedestrians from using “Voie des Bâtisseurs”.

7. RENEWAL AND UPGRADING STRATEGY

Following the decision taken in 2007, these tunnels must be refurbished to comply with regulations. The requirements of the French Technical Instruction do not always apply because the tunnel is non-standard. Therefore, it was necessary to return to the "basics" in re-expressing qualitative targets to meet the safety of this underground network.

Analysis of the new operating and safety conditions has been made according to four main axes:

- Operation and monitoring of the tunnels, as well as alarm system;
- The possibility of self-rescue of users;
- To maintain optimum conditions for the intervention of emergency and rescue services;
- Protection and compartmentalisation of the networks to limit the consequences of an incident.

Four main provisions of modernisation are under review and will be implemented. The control centre and fire risk provisions were presented respectively to §6.1 and 6.3 above. The two other provisions concern:

- Harmonisation and consolidation of the operation tools via a transversal improvement works programme for all structures, primarily concerning monitoring, detection of incidents and alert;
- The modernisation of each of the tunnels with specific renovation works. This refurbishment program concerns the following:
 - construction of escapes and safety recesses, remodelling of the cross section, etc.
 - fire protection,
 - subdivision towards third-party spaces,
 - lighting,
 - power distribution,
 - normal ventilation and smoke extraction,
 - signalling,
 - implementing FFFS (fixed firefighting system) in specific areas (parking for 2 wheeled vehicles - refuse storage areas, etc.).