

7. OTHER EQUIPMENT & OPERATING FACILITIES

7.1. CONVENTIONAL EQUIPMENT

All tunnels that have been investigated are fitted with the usual operation and safety equipment. This equipment are presented in many *PIARC publications*. Therefore they are neither listed nor detailed in this report.

In some of the tunnels particular efforts have been undertaken in order to improve the comfort and the safety of the users as well as the communication with them.

7.2. SPECIFIC EQUIPMENT

Some specific equipment has been noted during this analysis. They relate to the following provisions:

- *Kaisermühlen* tunnel in Vienna (A). A specific system allows better regulation of the speed of vehicles, improve the traffic, and increase the safety of the users;
- *Kaisermühlen* tunnel in Vienna (A). An acoustic system installed in tunnel allows to distinguish the normal traffic noise of the unusual noises such those of an accident or a violent braking. The acoustic alarms are transmitted to the control room and the images of the concerned zone are automatically activated for reducing the delay of information and consideration by the operators
- *Croix-Rousse multimodal* tunnel in Lyon (F). A dynamic animation of the side walls has been installed inside the multimodal tunnel. This facility is intended to enhance the comfort of pedestrians during passing through the tunnel (walking duration about twenty minutes), and to promote pedestrians and cyclists use.

7.3. SIGNAGE

7.3.1. Signage in underground interchange

The quality of the visibility and the legibility on the exits to the ramps is an essential parameter of safety for a complex underground network. The signage of the interchanges also contributes to the general safety conditions.

The limited space available makes the integration of the signage often difficult, in particular in case of a construction method with a TBM or a shield.

In some tunnels that have been investigated the poor design of the exit and the signage contributes to dangerous behaviour of the drivers and an increase of the risk level and the incidents.

In order to avoid late and unexpected actions from the drivers near the exits, some tunnels are fitted with specific and unique designs at each exit. This makes it easier to orientate in the tunnel complex, and make easier for the drivers to plan their driving and choose lanes early.

Examples of this are the Southern and Northern link tunnels in Stockholm, where the places where the drivers have to make decisions are decorated with colours and artistic installations (see *illustrations 27 & 28* below).



Illustrations 27 & 28 – design and signage of an exit on the Southern Link in Stockholm

7.3.2. Guidance of the users and the emergency services

Another important issue to take into account in the tunnels is to ensure the immediate action of the emergency services in case of any incident. This is much more difficult in case of complex tunnels because there are many different tubes, and many different exit and entrance ramps where the incident can occur. Besides that, these complex structures are usually very long and users can not identify the point where they have stopped.

In the case of the M30 tunnels in Madrid, a guidance system using an alphanumeric code has been implemented that has been painted on the walls of the tunnel every 20 m. In the case of the M30-Bypass the same code on the walls has also been painted in the emergency gallery that is just below the road.

As soon as the incident happens, the operator communicates to the emergency services the code number where the incident is. The First Intervention Agents and Maintenance Support (composed of one Fire Truck, one signage lorry and one crane lorry) can arrive to the incident location very quickly thanks to this guidance system. In case of M30-Bypass, the emergency services use the gallery that is below the road to get to the incident; for that reason the code has also been placed inside it.

The alphanumeric code has a number that indicates the kilometre and the decametre of the road in that point and two letters to identify the tube, if it is a main tube or it is a ramp, (see *illustrations 29 & 30*).



*Illustration 29 –
Alphanumeric Code for M30-Bypass. In this case,
the same code is placed also on the walls of the
emergency gallery that is below the traffic space.*



*Illustration 30 -
Alphanumeric Code for M30-Rio tunnel*

For M30 By-pass the users are guided in case of fire in the direction of the escape routes located underneath the traffic spaces. The signage inside the connection galleries includes variable messages in order to guide the users in the direction of the escape located inside the tube that is not involved by the fire.