

**Technical systems of tunnels  
Železnik (699m) and Lipak (669m)  
Financed by: Koridori Srbije Ltd. Belgrade  
Project completion year: 2013.**

### Project description

After the public procurement procedure, Koridori Srbije Ltd. entrusted works on the rehabilitation and equipping of the tunnels Lipak and Železnik to the local consortium led by the Institute Mihajlo Pupin – Automation & Control Systems Ltd. Works began in June and ended in November 2013 and included renovation of existing electric power installations, communication, signal and transport, and control and protection systems.

Projects of Železnik and Lipak tunnels covered the first phase of construction of both tunnels, which involved the utilisation and control of one tunnel tube with two-way traffic and a total of two lanes. Since the second phase of the tunnel construction included building a control centre at Petlovo Brdo from which monitoring and control of the objects would be conducted, the project also included the connection to a remote control centre. Both tunnels were equipped with operating command centre where signal and telecommunication installations were located, as well as the power unit and the central control computer system. Two niches for storing of electrical equipment were put in each tunnel, as well as the evacuation passages between two tunnel tubes.

### Applied technology

The tunnels are an important segment of modern roads because the passage through them has to be as safe and comfortable as possible. Tunnel management is an important part of ITS because it ensures optimal transport and technical conditions on a road segment where it is located. Following the principle that quality, reliability and technical characteristics of each subsystem element must substantially contribute to the safety of road users, the Institute applies the most advanced technical solutions for the control of tunnel subsystems.

System for monitoring and control in tunnels Lipak and Železnik was completed by using the VIEW4 SCADA system, made by the Institute Mihajlo Pupin. It enabled the operators to monitor the status of all subsystems on the screen in the control room and to control specific groups of devices.



SCADA system communicates with PLC devices and has the possibility of archiving signals and events. Installed PLC controllers are the latest generation of Atlas-Max RTL® controllers which are also brand of the Institute Mihajlo Pupin. These controllers allow communication with a wide range of different devices using designated protocols and simultaneous execution of control programs. They are located in the tunnel niches and operating command center. The main unit is in the command center, while the controllers in the niches are used to collect digital and analog measurements and to execute the end commands.

Tunnel management system can operate in automatic or manual mode. The operator monitors the status of the tunnel on the display screen and by video surveillance systems.

The status of alarms is monitored during normal tunnel operation. The regular operation is defined by the absence of alarms and by corresponding traffic signals. All foreseeable emergency situations that may arise during the tunnel operation are covered by the Tunnel work plan and they include:

- Normal working conditions
- Maintenance and other foreseeable situations
- Emergency events (incidents) in the tunnel (fire, rising levels of carbon monoxide, accidents, break-in, etc.)

If an accidental situation occurs the system reacts automatically by following the scenario in the Tunnel work plan, or the selected command can be executed manually by the operator. After the incident, only the operator can manually set the command to regular operation, having established that all conditions are met.

# TRAFFIC MANAGEMENT

## Tunnel Traffic Management



Design and implementation of supervisory and control systems in tunnels Lipak and Železnik on the Belgrade bypass included the control of the following subsystems:

- Fire Alert System
- Burglar Alert System
- Video Surveillance System
- Intercom Communication System
- Air Control System
- Traffic Detection System
- Audio System
- Radio Link System
- Traffic Signalization Control System
- Central Control System
- Tunnel Lighting
- Low-voltage Installations
- Ventilation
- Operating Command Center
- Hydrant

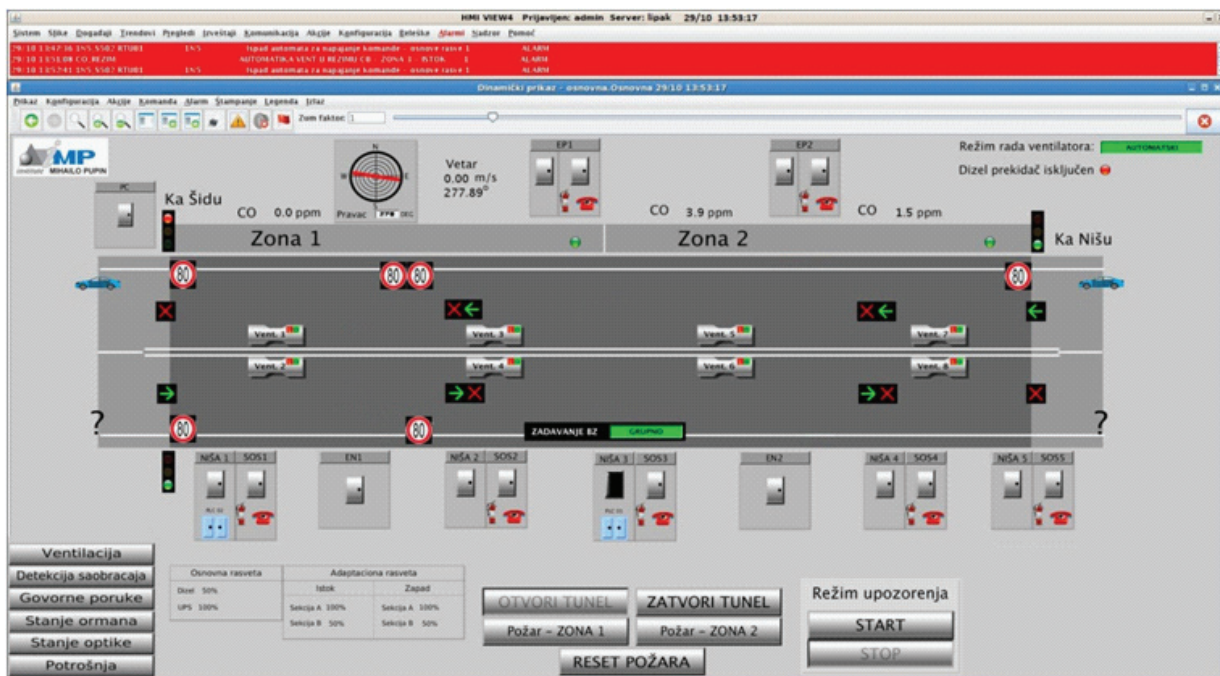
### Advantages of the applied solution

Belgrade bypass with tunnels Lipak and Železnik is of great importance, primarily because of the relocation of the transit traffic from the city. It also significantly shortens travel time on Corridor X and at the same time reduces traffic jams, noise and pollution in the city and decreases the risk of transporting dangerous goods through Belgrade.

Safety plays the key role in efficient functioning of the traffic in tunnels. Control system in tunnels Lipak and Železnik is accordingly precisely planned and realized by implementing cutting edge equipment and safety procedures which are executed automatically in the case of an emergency.

For the smooth traffic flow the introduced video surveillance system is of particular importance. During the regular operation of the tunnel it monitors the traffic and enables the operator to supervise the situation in the tunnel on the display. Moreover, the traffic detection system is used for monitoring the traffic frequency, vehicles speed and their classification. Based on the obtained data general traffic condition is obtained and that gives the operator the time to react and to perform the appropriate command manually, e.g. to change traffic lights and timely inform drivers about traffic flow in the tunnel, restrictions or forbiddance of traffic, or to close the tunnel from SCADA if necessary.

Completion of the works on System for monitoring and control of technical systems in tunnels Železnik and Lipak increased safety and speed of traffic on this part of Belgrade bypass and enabled its more efficient use.



Basic dynamic display of the tunnel