ELECTROMECHANICAL SOLUTIONS FOR TRANSPORTATION AND RAILWAY SYSTEMS
Transportation Systems

Transportation systems, which are an important part of our daily life, are being modernized with developing technology. Today, new modern automation systems are increasing life safety, maintenance quality and significantly decreasing system black-outs and malfunctions in transportation systems such as highways, subway, tram, light rail and railways.

The Automation Systems which are used in highway and railway tunnels provides in-tunnel control and increase safety.

Control and Safety Requirements and related variables may change according to the type of transportation systems. We are providing consultancy, system and project concept design, electromechanical manufacturing, software developing, on-field testing and commissioning, on-site training and after sales services to our customers in the turn-key solution businesses.

In addition to determining the needs of the system and establishing the appropriate infrastructure, it is undoubtedly important to ensure the continuity of the business.

The installed PLC and SCADA systems in redundant and Client-Server structures ensure the continuity of the business and prevent possible malfunctions. One of the most important advantages of redundant structure is to ensure that maintenance and repair works are carried out without stopping the planned and current operation.

INSTALLATION OF THE TRANSPORTATION SYSTEMS ACCORDING TO DIFFERENT NEEDS

Highways
- Tunnel Control and SCADA centers
- Traffic Control and Management Systems
- Tunnel JetFan Systems
- Tunnel Lighting Fixtures and Control Systems
- MV&LV Distribution Switchgears
- Emergency Power Supply Systems
- Fire Detection and Fighting Systems
- IP Camera and CCTV Systems
- Traffic Signalization Systems
- Vehicle Tracking and Classification Systems
- Computational Fluid Dynamics Systems (CFD)
- Driver Information Systems
- Communication Infrastructure Systems

Metro and Light-Railways Systems
- SIMS and ECS (Environmental Control System) and mechanical equipment
- SCADA Systems and related panels
- In-house design and manufacturing for MDP LDP/MCCs
- Computational Fluid Dynamics Systems (CFD)
- Tunnel Ventilation and Smoke Extraction Systems
- IHK operation scenarios and test procedures
- Tunnel Fire Fighting scenarios and test procedures
- Tunnel Ventilation System Panels and its control systems
- Tunnel JetFan Systems
- Elevators and Escalators
- Automatic Gate controllers

Railways
- Total Solution for Electric Systems
- Distributed RTU structures and control systems
- Power Factor Correction and Quality solutions
- Static VAr Compensation Units SVC/SVG/STAATCOM
- SCADA and power control centers
- ICCP Tele-control and Telecommand Centers
APPLICATIONS IN TRANSPORTATION SYSTEMS

Lighting Control
Tunnel entrance, interior and emergency lighting levels are adjusted according to the outdoor light level.

JetFan Control
Ventilation is provided by jet-fans which are activated in case of smoke formation and prevent to possible accumulation of exhaust gases in the tunnel. Jet fans also play an active role in smoke evacuation in case of fire inside the tunnel.

Traffic Signalization Systems
The system is control and coordinate to traffic lights, variable speed signals, lane control signals, fog lamps, variable message signals (VMS / VTS) in the tunnel and tunnel entrance.

CCTV and Event Detection System
The status of the tunnels is examined physically through cameras placed in the tunnel entrance, interior sections and exits. The system continuously tracks the vehicle classifications, accidents, standing vehicles, reverse vehicles detection, pedestrian detection outside the vehicle and vehicle navigation speeds.

Passenger Information Systems
Passengers are informed about location of the upcoming vehicle, possible changes for the expedition time and the estimated time of arrival vehicle.

MV&LV Switchgears and Substation Automation
Monitoring and controlling of the systems such as transformers, diesel generators, LV and MV switchgears and uninterruptible power supply systems are carried out in order to ensure continuous operation of the entire facility.

CFD Analysis
That is the analysis for the evacuation of exhaust gases that can accumulate in the tunnel, smoke emission and calculation of temperature distributions in the case of fire and determination of whether the emergency fans will function as programmed and calculation of actual fan forces and their position changes if necessary.

Fire Fighting and Security Systems
The fire inside the tunnel is detected as soon as possible and extinguished in the shortest time frame and thus ensure the continuity of tunnel security.
ECS

ECS is a common platform for the different monitoring and control systems such as HVAC, plumbing and drainage systems, day/nighttime and emergency lighting systems, fire detection and alarm systems, emergency announcement and evacuation guidance systems, turnstiles, access control and escalators/elevators. The escalators/elevators, turnstiles and access control systems are serving as package type control systems with passenger information interfaces that provides data transfers via standard communication protocols.

MCC Switchgear Manufacturing

Motor Control Centers are an integral part of the LV system as well as an important part of the control systems. In all installed MCC systems used standard distribution boards (including Form 4b) have been manufacturing according to IEC 60439-1.
Electric and Automation Systems
To ensure the continuity of the energy in the power grid that feeds a transportation system and to access the control parameters instantly and accurately at the requested time is very important in terms of the functionality, safety and effective control of the transportation system.

Video walls are an interface to monitor information at the focused point of the transportation system and display visualized information via SCADA. It is very easy to perform daily /emergency operations such as tunnel control and traffic monitoring, ventilation, lighting, traffic signaling and fire safety in highways and rail systems with CCTV & Videowalls.

In fact that the most updated technology of the mainstream servers of the video walls and the whole control systems increases the functionality, security and flexibility. In this way, it is possible to meet future needs if the actual system is expanded. Backup structure, archiving, easy database integration and open code system are other important features of the servers.

In the transportation system, DCSs (Distributed Control System) are located at the top of the control mechanism and all other automation systems are transferred to SCADA via DCS. The complete control architecture from the HV switchyard to the MCC panels in the substations or from fire pumps to ventilation systems is transferred to SCADA via DCSs then system monitoring and controls are provided by video walls.
SCADA Systems
SCADA (Supervisory Control and Data Acquisition) is the general name of the controlled system that can be created by computers, communication devices, sensors or other related devices. SCADA is the main infrastructure platform for all kinds of inspection, control and monitoring systems in highways tunnels, railway systems and tunnels and stations. It also helps to visualize the controlled information. SCADA provides easy and quick access to process information and helps to take precautions against possible malfunctions.

Control Systems
In a transportation system; Lighting, security, traffic signaling and ventilation systems are responsible to carry out major control operations. Control systems such as PLC, compact or advanced DCS are used in every step of system architecture in transportation systems.
**PLC Systems**

PLCs are the ideal solution for different automation needs from simple to complex, requiring high performance, low cost and flexibility. Kontrolmatik automation platform, is capable to meet increasing system needs within its scalable structure thus guarantees investment.

**Kompakt DCS Systems**

Compact and scalable DCS systems offer powerful automation functions as well as low cost advantages in hardware and software. Kontrolmatik DCS system solutions which offers minimum engineering and maximum automation capability, have an open and modern system architecture and also possible to reduce the cabling costs with distributed controllers in the field.

With Compact DCS systems, which requires a single software for application engineering, commissioning, diagnostics and fieldbus management can be fully integrated into the control system. The pre-engineered visual components at the operator level are just one of the many advantages it provides.

**Advanced DCS systems**

Advanced DCS systems are used to reach all existing applications and multiple data from the tunnel control room. Advanced DCS systems offer effective control to reduce risks and costs. The integrated infrastructure minimizes the entire system from planning to configuration, from library management to onsite commissioning and creates efficiency within supporting the life cycle of automation projects. Moreover, with its powerful reporting feature it records and processes all the system information.
POWER DISTRIBUTION SYSTEMS

It includes high and medium voltage systems, such as transformers, boards, relays and circuit breakers, which are the main power source that supplies the transportation system, and the related protection circuits and power system automation of all these systems. Systems created with IEC 61850 compliant devices ensure safe operation in the most demanding environments without compromising performance and also guarantee the quality and continuity of the energy in the system.

Well known brands’ world-class protection and control solutions are our preferred products for reliable power transmission and distribution. Our protection systems offer the widest range of products for protection, measurement and control for IEC and ANSI applications in power systems. Different solutions are used for different applications such as transformer protection, line protection, breaker protection.

Remote control of the power system is carried out via a flexible and modular designed RTUs (remote terminal units). The RTUs are perfectly adapted to the scalability in the power distribution system. The open architecture of the RTU’s adapts to different applications and has all kinds of expansion possibilities.

The advantages that the RTU provides to the system are as follows:

- Reduces operating and maintenance costs through advanced diagnostic tools
- Configurable hardware for all applications brings a small number of spare parts and reduces costs.
- With integrated Human Machine Interface (HMI function, it creates PLC and network components functions with a single RTU system
- Reduced engineering hours with efficient engineering tools
- A single RTU solution for the entire system from the complex to the simplest

The Main Components of System
- MCC Panels
- Low Voltage Distribution Panels
- PLC’s
- AC Drivers

The Main Applications
- Jetfan Control
- Firefighting Pump Control
- Illumination System Control
- Vehicle Signalization Control
This system includes monitoring and control of entire sub-systems such as normal and emergency lighting, fire and smoke detection, escalators, voice alarm and routing systems, turnstile systems, access control systems and elevators in a metro station and road tunnels.

For effective and safe control in a transport system, the accuracy of the data received from the field and the rapid transmission of information to the main control mechanism is required. Intra-tunnel light sensors, air flow and directional sensors, fire and smoke detectors are the other devices that complete the transport system infrastructure.
ENGINEERING SERVICES

Kontrolmatik also provides engineering services other than the installation of transport systems infrastructure. The most important of these is the Computational Fluid Dynamics (CFD) analysis. This analysis constitutes the most important part of the ventilation systems in the highway tunnels. In order to keep clean and dirty air densities at every point in the tunnel and to ensure effective smoke evacuation in case of fire, the ventilation system should be designed according to the tunnel cross section and structure. CFD analysis is the dissolution of air movement within the tunnel by the computer with mathematical equations. According to this analysis, the ventilation system is structured.

The classical fluid mechanics technique remains unresolved when different types of tunnels, weather and climatic conditions are considered. Therefore, in order to obtain close-realistic results, the air flow is divided into small elements to a grid form. With this discretion, the problem can be solved in computer platform. The starting value of the flow is determined. These initial values are used and checked by comparing the calculated value with the previous level. The difference is considered to be an error. The solution may also acceptable when the error value for each equation drops to an acceptable value.

CFD analysis is one of the major analysis methods used in many industries such as aircraft, aerospace and aviation industry, white goods, defense industry and automotive industry.
Kontrolmatik provides all the solutions you need with its expert staff in control and management centers.

**Videowall Systems (DLP cube)**
DLP cube solutions are more professional imaging systems than LCD / Plasma equipment and display cubes can be arranged according to the needs/dimensions of the control center. Because of the screens are not framed, there will be no loss of image quality and they can operate 24/7.

**DLP Cube application locations**
- Control and Monitoring Rooms
- Disaster and city coordination centers
- Metro and railway signaling center
- Telecommand Headquarters
- SCADA Control Centers

**Advantages of the DLP Cube system**
- Very Large Screen
- High resolution
- Working zones for multiple groups
- User friendly, ease of use
- Eliminating data loss
- Redundant system
Mechanical Systems

Tunnels play an important role in the global development of infrastructure and urban communication. Special needs are developing to ensure safety and air quality together with new transportation projects in addition to the new projects, the existing transportation tunnels are renewed according to these new needs.
TUNNEL JETFAN SYSTEMS

There are three main vehicle tunnels: highway tunnels, subway tunnels and railway tunnels. Electromechanical tunnel installations in coordination with the effective traffic control system create a safe tunnel environment for passengers and personnel under normal operating conditions and in emergency situations. The most important electromechanical systems in a transportation system are:

- **Mechanical systems**: ventilation, fire fighting, drainage
- **Electrical systems**: Power (supply, distribution, emergency)
- **Lighting systems**: Zones, lamps, brightness
- **Communication systems**: Radio, telephone, speaker system
- **Traffic system**: Monitoring, headlights, signals, signs
- **Control system**: Traffic / facility

In normal operation or in case of emergency, the fact that independent electromechanical systems can be well integrated into each other through interfaces is the most important prerequisite for ensuring tunnel safety.

The main purpose of the tunnel ventilation system is to maintain good air quality and to provide smoke evacuation in case of emergency. Other functions are controlling the amount of emissions in the tunnel, evacuating the emission from the tunnel entrances and ventilation system and providing cooling for the tunnel environment.

The emissions of road vehicles include nitrogen oxide (NO and NO2) and carbon monoxide (CO). Tunnel ventilation system is established to meet specified health requirements for maximum permissible concentrations. There is a clear trend towards implementing the maximum acceptable NO2 concentration criteria in accordance with World Health Organization recommendations. In the case of modern vehicles in some markets, the NO2 value for ventilation controls tends to replace CO as the main parameter. Ventilation may also be required in terms of visibility due to the smoke from the diesel engines and the wear on the road surface.

In the case of tunnel fire, significant heat loads (25-150 MW normal range) can be released. Smoke should be controlled and guided away from tunnel users so that escape routes are kept clean. In addition, the tunnel ventilation system must also be designed to perform evacuation in elevated temperature situations.

**TYPE OF VENTILATIONS**

**Natural Ventilation**
Natural wind speed, other meteorological conditions, tunnel inclinations or the piston effect that caused by moving vehicles. Piston effect of air flow affected vehicle in many one way short tunnels up to 300 m long will provide satisfactory ventilation in terms of normal ambient requirements.

Tunnels with lengths between 300 m and 400 m may require mechanical ventilation in terms of fire / smoke control.

**Mechanical Ventilation**
Mechanical ventilation is provided with four main types:
- Transverse Ventilation
- Semi-transverse Ventilation
- Longitudinal Ventilation
- Hybrid Ventilation

**Piston Effect**
Vehicles cause turbulence as they pass through the air, this turbulence will reflect the speed to the surrounding air. The limited airspace in the tunnel emphasizes these aerodynamic effects. A vehicle entering the tunnel behaves like a piston which is loosely seated in a tube, the displaced air is forced to flow parallel to the tunnel axis, while some of the air exits from the front of the vehicle, and some of it will go back through the vehicle tunnel ring.
**MECHANICAL TUNNEL VENTILATION METHODS**

**Longitudinal ventilation**
In the simplest form, the air flow moves from the tunnel inlet to the outlet of the main cross-sectional area without separate ventilation channels along the tunnel. In a tunnel with emissions from vehicles, fresh air comes only from the tunnel entrance. And as vehicles move through the tunnel, they are exposed to polluted air as they move away from the entrance. This system must be supported by longitudinal ventilation tunnels and central exhaust / fresh air ventilation stations connected to the atmosphere. At the exit, it may be necessary to use a fan exhaust shaft to control the exposure to contaminants in the enclosed area.

Jet fans mounted on the bottom surface or mounted on the tunnel walls can be used to support traffic under the action of the piston (ex: traffic congestion or rush hours)

**Transverse ventilation**
The transverse ventilation system includes centralized exhaust and fresh air fans with separate ventilation channels along the tunnel length. The fresh air duct is normally located at the road level, while the exhaust air duct is at a higher level. The inlet and exhaust vents are distributed along the ventilation ducts to provide the required ventilation distribution.

Due to the presence of a clean air source along the tunnel, the concentration of polluted air is reduced significantly.

Emergency ventilation can only provide by the exhaust system. The use of the transverse ventilation system together with the smoke extraction system and the additional jet fans provide a much better solution.
Semi-transverse ventilation

The semi-transverse system may be two types: supply (fresh air) or discharge.

Final selection of ventilation system belongs to optimization of construction, installation and operation costs, total energy consumption and distribution, air quality requirements, safety issues, emergency procedures, etc.

Hybrid ventilation

It is suitable for special applications. It is applied as various combinations of natural, transverse, semi-transverse and longitudinal ventilation. It is the best solution for long tunnels.
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VENTILATION SYSTEMS ACCORDING TO TUNNEL APPLICATIONS

Highway Tunnels
These are the tunnel type where ventilation is necessary to reduce the dangerous level of toxic exhaust gases during daily tunnel operations and also to eliminate of hot smoke in tunnel emergencies.

Type of Ventilations
The shape of the ventilation depends on the following principles:
- Location of the tunnel and its effect on the region environment
- Estimated traffic density information depending on design and operating years
- Tunnel geometry, altitude and regional topography
- Fire safety issues

Railway Tunnels
These are the tunnels where ventilation is required to get rid of heat and pollution during standard tunnel operations and to eliminate hot smoke in tunnel emergencies.

Design Factors
- Type of locomotive (e.g., diesel, electric)
- Adequate space for the shape of the tunnel and ventilation system
- System usage, ventilation, smoke exhaust or both

MRT (Metro Road Tunnels)
Ventilation is divided into two parts:

a) Stations
b) Tunnels

These are the tunnels where ventilation is required to get rid of heat and pollution during standard tunnel operations and to eliminate hot smoke in tunnel emergencies.

Various ventilation systems are integrated in MRT tunnels:
- Natural longitudinal, with piston effect
- Mechanical longitudinal
- Hybrid, push-pull
- Lateral in-line station
MECHANICAL SYSTEMS

The most important mechanical infrastructure of a transportation system is the tunnel ventilation system. Protection of air quality in the tunnel, air pollution prevention, smoke evacuation in case of fire and control of the temperature inside the tunnel are essential for safe and comfortable travel.

Causes of ventilation

- **Highway Tunnels**
  - CO and NO2 dilution
  - Dilution of particles
  - Increase visibility distance
  - Smoke evacuation in case of fire

- **Railway/MRT Tunnels**
  - Heat discharge
  - Clean air plumbing
  - Smoke evacuation in case of fire
ELECTRIC AND AUTOMATION SYSTEMS

Access to control parameters at any time and in the right procedure is very important in terms of ensuring the continuity of energy in the power grid that feeds the transportation system and its functionality, safety and effective control.

System Architecture
- **SCADA Systems**
- **Control Systems**
  - PLCs
  - Compact DCS Systems
  - Advanced level of DCS Systems
- **Power Distribution Systems**
  MDP/LDP/MCC/AUT Panels
- **Environmental Control Systems and Passenger Safety**
  HVAC, day/nighttime and emergency lighting systems, fire detection and alarm systems, emergency announcement and evacuation guidance systems, turnstiles, access control and escalators/elevators
- **Engineering Services**
  Computational Fluid Dynamics Systems (CFD) analysis
VENTILATION FANS FOR TUNNELS

Tunnel Jet Fans
- Increases the speed of air passing through
- Low speed air gains accelerate with high-speed jet (35 m/s) by mixing
- It provides the necessary speed and protection for ventilation in the tunnel.
- Jet fans are not subject to system pressures as channeled axial fan.
- Jet fan efficiency is determined by force (N) / used power (kW) and this value is not the same as the total fan efficiency shown in the axial fan specifications.

Jet fans are designed to give maximum thrust, which is as follows:
**Volume x speed x density**

Therefore, the maximum volume is obtained at the lowest point of the fan curve and they do not have “produced volume / pressure” type of specifications. The total thrust force required in a system must be sufficient to meet the required tunnel speed while overcoming installation and tunnel pressure losses.

Axial tunnel ventilation fans
Tunnel ventilation fans are required to support large amounts of air at high pressures to overcome tunnel resistance.

Tunnel ventilation fans provide the fresh air required for the tunnel and exhaust emission gasses and smoke at the case of fire.
TUNNEL VENTILATION ACCESSORIES

Dumpers
Dumpers are used for all underground (subway, road, rail) ventilation systems.

- **Fan dumpers**: It is used to stop the air flow of the fans and to separate the air ducts in parallel mounted fans. Normally larger than the fan diameter and connected to the fan through the transition parts (round-round or round-square). Normal level of air velocities is around 20-25m / s.

- **By-pass dumpers**: Allows the flow to be directed from one air system to another. It works especially when the needs to use the same fans for normal and emergency operations. Normally, its diameter is larger than fan dumpers, thus maintaining air velocity around 5m / s.

- **Tunnel dumpers**: Used in road tunnels with semi-lateral or lateral ventilation systems for fresh air inlet and / or exhaust air and fire smoke output. These are always suitable for emergency operation. Normally suitable for air speeds of less than 15m / s. It has a strong design that often accommodates electric actuators to ensure that the damper rotates to a predefined safe position (fully open).

Silencers
Splitter type of silencers are always used in subway ventilation systems to reduce noise levels emitted by fans. Depending on the tunnel location and local regulations, silencers are also used in urban or rural road tunnels.