ROAD TUNNEL APPLICATIONS

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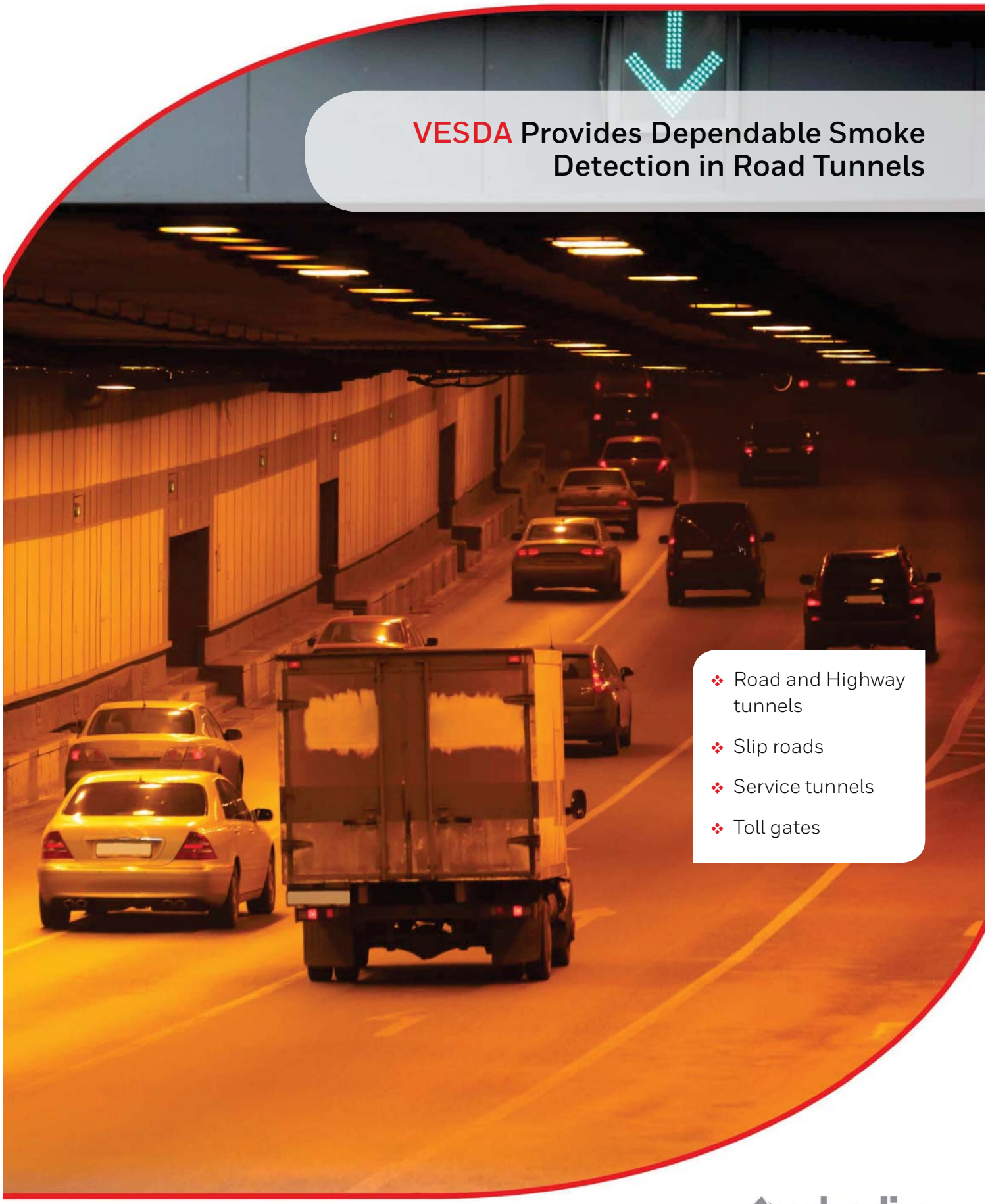
VESDA Provides Dependable Smoke Detection in Road Tunnels



- Road and Highway tunnels
- Slip roads
- Service tunnels
- Toll gates

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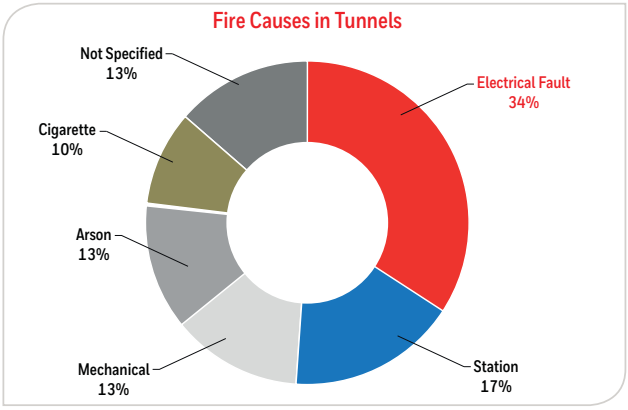
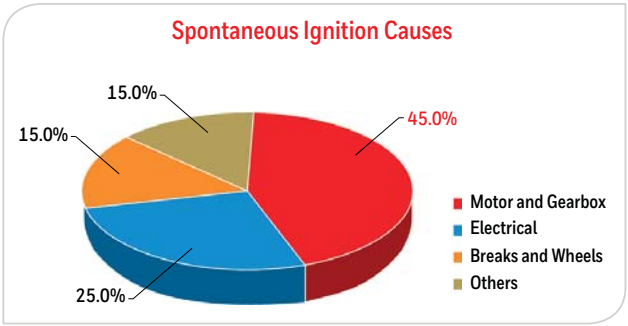
Exposure to smoke from most fires poses the main danger. In the event of a large fire inside a tunnel the risks that a motorist faces are various. To begin with, the visibility is decreased and the user is constrained to move through the smoke. Within a few minutes, due to toxic compounds in smoke, pain and breathing troubles occur given that irritants affect the respiratory tract. Another hazard concerns the heat generated from the fire itself. Heat can be an issue for evacuation close to the fire, but foremost heat restricts rescue service intervention and can damage equipment or the tunnel structure itself, potentially leading to collapse or expensive refurbishment.

Most of the materials that burn are carbon-based. The decomposition products of carbon-based fuels are mainly CO_2, H_2O and heat. Carbon dioxide (CO_2) is a toxic asphyxiate gas in large doses. Depending on the fuel composition, temperature and ventilation conditions, other toxic products can be formed, such as Carbon monoxide (CO). During an actual fire, vehicle emission such CO and nitrogen dioxide (NO_2) will be present due to traffic stoppage and idling vehicles.

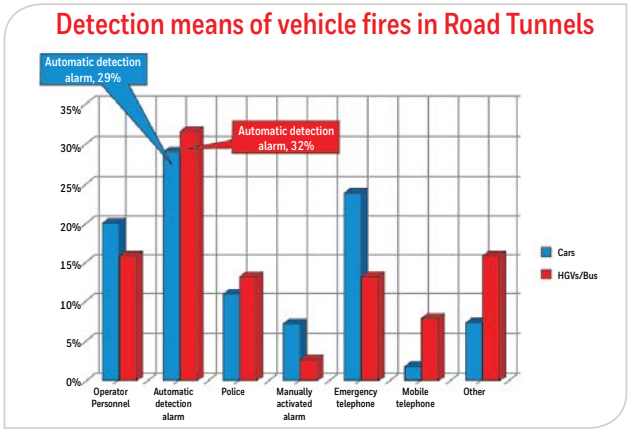
According to IFA (International Fire Academy), there is almost three fires in Road Tunnels every month



According to ASFINAG (*), near than 90% of the fires in road tunnels are due to spontaneous ignition



According to PIARC (**), 45% of the Spontaneous ignitions are originated by Motor and Gearbox



In road tunnels, one third of all vehicle fires are detected by automatic detection systems.

According to PIARC (**), more than 70% of the existing tunnels have been put into operation during the last 30 years

Road tunnels are difficult to access for firefighting, so even a small fire in this environment can rapidly lead to disaster. Passengers trapped underground of course panic which adds to the complexity and significance of a fire event.

A FIRE DISASTER CAN ALWAYS OCCUR

Interest in tunnel fire safety has increased dramatically in recent years owing to a number of catastrophic tunnel fires, all of which have earned extensive media coverage.

Probably, the most dramatic was the “Mont Blanc tunnel” that occurred on 24th March 1999, where 41 people died.

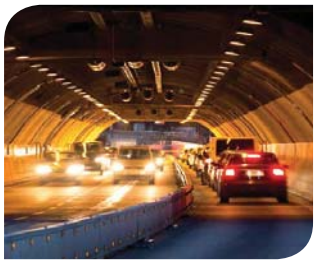
HAZARDS AND CHALLENGES

The most prevalent causes for road tunnel fires are collisions, overheating combined with either fuel leakage or electrical failure, overheated bearings from brakes, tyres or engines. Collisions involving Heavy Goods Vehicles (HGVs) or Dangerous Goods Vehicles (DGVs) are clearly predominated as part of the severe fires that caused fatalities. According to ASFINAG, only 6% of the fires were reported to have been generated by collisions, from which all were assumed to have affected the whole vehicle.

(*) ASFINAG was founded in 1982 and is an Austrian Federal Agency who plan, finance, build, maintain, operate and collect toll for 2,200 kilometres of Motorways and Expressways in Austria.

(**) PIARC (World Road Association) is a non-profit organisation established in 1909 to improve international co-operation and to foster progress in the field of roads and road transport.






The turbulent environment and air flow velocities within a tunnel, due to the propagation of pressure waves may prevent the rapid accumulation of heat directly above a fire incident. In addition flame spread may also prevent the rapid build-up of heat directly above a fire. Both of these conditions can delay the detection of a fire. If the smoke is not detected quickly early intervention will not occur, smoke will be transported downstream of the fire event, resulting in detection away from the actual fire. This creates a level of ambiguity and confusion compromising a rapid response to the fire location. In addition the tunnel turbulence and airflow will interfere with the formation of the initial smoke plume and dilute the concentration of smoke and other products of combustion.

The reality is, traditional smoke detectors installed in tunnels suffer from reduced sensitivity, extensive nuisance alarms and premature failure due to pollutants such as dust, and other contaminates found in these environments, including humidity.

CONSEQUENCES OF SMOKE OR FIRE IN A ROAD TUNNEL MAY

- Endanger lives of passengers, staff and emergency services in the course of evacuation and panic
- Prevent or slow-down rescue services interventions
- Produce critical damage to equipment such as smoke contamination within electrical equipment
- Cause massive structure destruction making the tunnel impracticable for a possible long period
- Affect passenger or commercial services
- Lead to severe litigation and potential tremendous damage liabilities

EXISTING TECHNOLOGIES: STRENGTHS & WEAKNESSES

Historically, it has always been considered impractical to provide a reliable smoke detection system with discernment of heavy traffic versus an incident. Traditional technologies and point-type detectors pose significant installation and maintenance costs.

Technology	Strengths	Weaknesses
Point-type heat detectors	Low initial product cost	Under minimum airflow conditions, the detector has trouble to detect small fires. It usually responds to fires of 1,500 kW or larger. Longitudinal airflow in the tunnel delays the response time for these systems. Service time increases and early failures occur due to dirty and dusty environments
Linear Heat detectors	Response to the fire scenario based on fixed temperature or rate of temperature rise	The longitudinal airflow in the tunnel delays the response time for these systems for most scenarios as the temperature at the ceiling decreases with the tilting of the flame and cooling of the fire plume by the airflow
Flame detectors	Response for detecting open fires based on field-of-view (FOV) characteristics	Due to field-of-view limitations, it encounters troubles in detecting fires located under, behind or inside a vehicle. The devices facing the on-coming traffic become very dirty with grime on the sensor windows, increasing service time
Video detection systems	Response for detecting open fires, based on field-of-view (FOV) characteristics	The longitudinal airflow in the tunnel affects the build-up of smoke in the tunnel, and decreases the time available for detectors dependent on field-of-view to detect a fire especially when it comes to concealed fires

APPLICATIONS THAT OFFER A PARTICULAR STRONG SOLUTION-FIT

Road tunnel applications present various challenges to effective and reliable smoke detection and on-going maintenance.

Applications	Causes	Consequences	Detection Challenges
Road tunnels	Collisions with high fire loads vehicles (HGVs, DGVs), electrical circuit malfunctions, and equipment cabling faults, lighting short-circuits	Critical impact on operational function, loss of high value assets, and extensive downtimes. Injury and loss of life from smoke exposure and panic	Incipient slow-growth fires, longitudinal airflow delaying the response time, accumulation of dusts and pollutants
Control rooms	Large amount of equipment and cabling installed in very compact spaces and concealed areas	Injury and loss of life from smoke exposure	Incipient slow-growth fires, low smoke levels diluted at source by high airflow HVAC systems. A fire may also rapidly spread due to the presence of large amounts of combustible materials
Substations	Electrical arcing and the build-up of static electrical charge within equipment, overheating of electrical control equipment, switchgear and cabling	Injury and loss of life from smoke exposure. Fire can spread to other critical installations. Loss of high value assets, long time to replacement	Incipient slow-growth fires, low smoke levels diluted at source by high airflow HVAC systems. High levels of background pollution present in these areas especially in cable trenches
Air handling & Filtering systems	Filter fires, general area fires	Injury and loss of life from smoke exposure and panic	High airflow causing dilution and high maintenance

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WHY USE A VESDA ASPIRATING SMOKE DETECTION SYSTEM?

The longitudinal airflow in the tunnel dilutes the smoke and this delays the response time for traditional detectors. Additionally, harsh environmental conditions due to dust accumulation and other pollutants can alter the reliability and robustness and generate unwanted alarms and premature detector failure. The solution is to use an industrial detector, such as VESDA VLI, which has been specifically designed to deal with such challenging conditions.

In addition to providing superior smoke detection, the VESDA VLI combined with VESDA ECO gas detectors would provide smoke and gas detection throughout the tunnel. Point-type gas detectors traditionally used in tunnels are plagued by the same airflow and turbulence challenges which affect traditional smoke detection. CO, NOx and other gases may be diluted throughout the space making detection with standard detectors problematic.

By leveraging the air sampling pipe network used for smoke detection together with gas detection, traditional point-type gas detectors are not required. Maintenance is centralized rather than being distributed throughout the tunnel, reducing cost, increasing safety and being more accessible.

VESDA detectors buy "TIME", time to respond to a fire threat, minimizing damage and business downtime. They provide:

- Detection of both small incipient smouldering fires and large flaming fires
- Detection of both smoke and gas throughout the tunnel
- Very early warning that gives time to perform a safe evacuation
- Superior performance in harsh environments and a high resistance to contamination
- Flexibility in design for on ceiling, underfloor voids, cable ducts and across return air intakes, as well as in targeted equipment sampling such as electrical cabinets
- Multiple configurable settings to provide, for example, very early warning for investigation, and subsequent warnings to initiate and execute a fire response plan, evacuation or suppression

VESDA DETECTORS SUITABLE FOR ROAD TUNNELS APPLICATIONS

Xtralis protects road tunnels around the world by providing an actively monitored sampling system, detection performance and reliability, sensitivity consistency over time and efficient response to ineffective detection solutions. Our VESDA VLI and ECO detectors have been certified SIL 2 as per IEC 61508 which provide the end-user with a safety integrity rarely achieved.

Equally, the high IP rating of both VESDA VLI and ECO detectors makes their use suitable for harsh conditions where dust and moisture are predominant and where regular wash-down operations occur.

VESDA VLI 	Maximum area coverage of 2,000 m^2 (21,520 sq. ft.)
	Up to 4 inlet pipes
	Total pipe length 360 m (1,181 ft.)
	Maximum single pipe length 120 m (394 ft.)
	Absolute smoke detection
	Clean air barrier for optics protection
	Patented fail safe intelligent filter
	Air flow continuous monitoring
	Patented In-field Clean Air Zero
	Auto learn smoke levels & thresholds
	IP66 ABS enclosure
	Conformal coating for improved corrosion resistance
	NEC 500 Class I Division II - Class A, B, & C fires
	SIL 2 rated according to IEC 61508
VESDA ECO 	Multiple gas-sampling points for better area coverage
	Use of the existing VESDA ASD pipework
	Catalytic beads (flammable gas or vapour) Electrochemical cells (toxic gas and oxygen)
	Non Dispersive Infrared (Carbon dioxide)
	Direct interface to FACP, HVAC and BMS using relays, 4-20 mA and Modbus outputs
	PC (Polycarbonate) / ABS IP54 enclosure
	NEC 500 Class I Division II - Class A, B, & C fires (ECO-EX only)
	SIL 2 rated according to IEC 61508 (SIL 1 for Electrochemical cell)

To learn more, please visit us at

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