Application Report
Early Fire- /Smoke Detection in Road Tunnel

SIGRIST PROCESS-PHOTOMETER

Fire incidents in road tunnels happen more often than generally recognized. It's only when such incidents reach a major event where people loose their lives and the damage forces closure of the tunnel for a long period, they become an issue of public interest.
The examination of various incidents demonstrates that in the majority of all tunnel fires, the principal cause of death is not primarily the fire, but the inhalation of toxic gases. Therefore, an early and reliable smoke detection using a FireGuard has proven to be essential.

Benefit
In case of a fire incident, the first minutes are most critical: an early and reliable detection of smoke allows initiating the safety and rescuing scenario allowing the people to escape the area by them selves. The exact localisation of the incident is important for the control of the ventilation system and the fire dampers in order to minimize the incident just to the affected tunnel areas, and not allowing spreading. It also helps the rescue team to execute their mission most effectively.
Finally, an early smoke detection helps to contain matters, whilst preventing further damage to the infrastructure. The resultant direct and indirect cost consequences of such a tunnel fire bear no comparison to the investment of such a protection system.

Typical Application
Most tunnel incidents occur due to smouldering fires caused by technical problems within the vehicles themselves. This includes over-heated engines, faulty turbo chargers, locked brakes, defective tires, etc. In all these cases, the visibility is quickly and drastically reduced.

From experience it is known that the linear fire alarm cables normally already installed in the tunnel cannot detect such incidents. Such systems only react once there is an open fire which causes a change in the temperature. Neither are video detection systems able to cope with such situations as too many false alarms are triggered due to light reflexions from windscreens, change of contrast, etc.
The importance of a reliable smoke- /fire detection method has been recognized in the meantime by many countries. However, up to now, only very few countries have defined clear requirements for such systems. The most comprehensive guidelines have been summarized by the Swiss Federal Road Office (FEDRO).
These guidelines can be summarized as follows:
- There must be a system installed for the automatic fire detection in all tunnels where there are safety installations and/or a ventilation system installed for incidents.
- The recommended distance between smoke detectors should be 100 m.
- The automatic fire alarm system described in the guidelines should not trigger more than 1 false alarm per year and per 2 tube kilometres.

There are further requirements concerning the method of installation, maintenance interval (max. once per year) and the requirement to compensate for or to eliminate the effects of fog.
Since 2007 the FireGuard are successfully installed in road tunnels for early smoke- /fire detection. The sensor works on the principle of scattered light and has no moving parts. Various options for the installation and communication allow a flexible integration in new or existing tunnel constructions. Several fire tests with simulated and real incidents, including the verification of incidents which occurred in tunnels with installed sensors confirmed the quick reaction in case of smoke development. Optionally, the integrated temperature measurement in the FireGuard can be used to localize any following fire.

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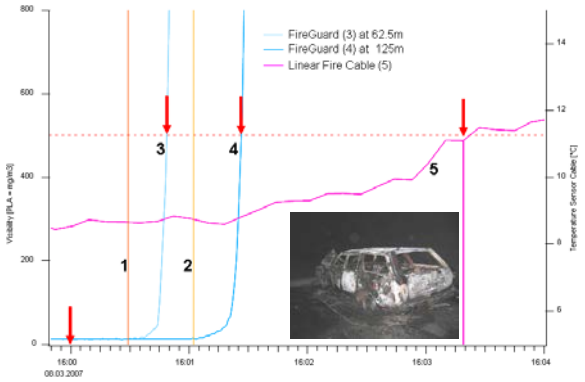
Practical Measurement (Example):



The diagram shows the results of a real fire test with a passenger car. The fire was ignited at 4 pm (first arrow on the left). The next two vertical lines (1&2) mark he earliest possible alarm based on the wind speed and the distance to the FireGuard sensors, which were installed at 62.5m and 125m after the source of the fire. The dotted horizontal line marks the set alarm level. The blue lines (3&4) show the signal increase of FireGuard. The set alarm level (arrows on the dotted line) was exceeded after roughly 20 seconds. For comparison: the linear fire alarm cable (5) only reacted once the flames came out of the car (arrow on the right side). The delay compared to the smoke sensor was more than 3 minutes!

Examples of follow up costs after a fire incident

The human tragedy of a fire incident cannot be expressed in figures. The cost for repair and the loss of income due to the interruption of the transportation network has been summarized for some of the incidents:

Year	Incident	Location	Loss in Mio. EUR
1999	Fire of a truck	Montblanc-Tunnel (Italy – France)	▪ 41 People died ▪ 350 to 450 Mio., plus 500 Mio. due to the interruption of the transport networks
2001	Truck collision	Gotthard Tunnel (Switzerland)	▪ 11 People died ▪ 6 Mio. Repair cost
2008	Fire of a truck containing chemicals	Euro Tunnel (England – France)	▪ 60 Mio. Repair cost ▪ 200 Mio. Income loss

The calculation comparison between the cost to construct or refurbish a tunnel and the investment for the installation of an early fire /smoke detection system using the FireGuard demonstrates that the additional cost counts only for approximately <0.5% of the overall capital costs.

Products

SIGRIST Product and Configuration for this Application:

- FireGuard (various configuration)
- Optional WLAN module
- Connection box SIPORT 2 with module PowerRel, Modbus RTU or Profibus DP
- Checking rod
- Mounting set (various configuration)
- Optional: sample heaters, cable

Parameter Setting

- Selection of the desired switching points for pre-alarm (typical: 10mE/m) and main alarm (typical: 30mE/m)
- Additional parameter settings can be made using the optional control unit SICON C or via the digital interfaces

Advantage of the SIGRIST FireGuard

- Compact design, no moving parts
- Mounting on the wall, on the ceiling, in the intermediate ceiling or incorporated into the ventilation dampers
- Flexible system integration
- LED light source, very low power consumption
- Continuous monitoring of the instrument status in the background
- Simple calibration using a checking rod
- No false alarms
- Extremely low maintenance cost