Early Fire Detection in Swiss Road Tunnels with more than 1’000 FireGuard Sensors

2nd «Tunnels and ITS» Symposium
Bergen, 18/19th September 2013

Willy Schuldt
Yes, it happens!
FEDRO standard for fire / smoke detection
SIGRIST FireGuard
1. Project: Gotthard Tunnel / 2007
Project: City Ring West, Zurich / 2009
Overview: projects concluded / planned
Practical experiences
Video clip: Smoke test of a Swiss road tunnel
Yes, it happens!

- June 19, 2011: Coach with 59 passengers caught fire in a tunnel of the city ring west, Zurich
- Damage: € 400’000
Yes, it happens!

• April 4, 2012:
  A coach with 74 passengers caught fire just in front of the entrance of the «Gotthard» tunnel
Yes, it happens!

- Juli 13, 2012: Due to a motor damage, a car caught fire in the «Gubrist» tunnel
- Damage: € 160’000
Yes, it happens!

- October 25, 2012: An Italian truck caught fire in the «Gotthard» tunnel
- Damage: €400’000
Yes, it happens – unfortunately also in Norway!

August 5, 2013: Fire in the “Gudvangen” tunnel, 80 people hospitalized with smoke poisoning

August 11, 2013: Fire in the “Stavanger” tunnel

August 22, 2013: Fire in the “Storsand” tunnel, 1 person killed
The automatic system must be able to localize a fire within a maximum distance of 100 meters in less than 60 seconds.

The automatic fire detection system shouldn’t trigger more than one faulty alarm for every 2 kilometer per year.

Fog must not be detected as smoke.

*FEDRO Switzerland: Legislation for fire detection in road tunnels - Edition 2007, V 2.10
SIGRIST “FireGuard”

» Measuring principle: scattered light
» No moving parts
» Response time: T90 in 5 second
» Integrated temperature sensor
» Fog elimination with heating elements (option)
» Signal output via relays or Profibus DP
» Installation on the wall, ceiling or in the intermediate ceiling of the fresh air channel
FireGuard: Flow & Optical Setup

Reference Beam
Temperature Sensor
LED Light Source
Receiver
Air Flow

- June 2006: Presentation of the first prototypes
- September 2006:
  - First test installations
  - Collecting data from real incidents
  - Analysis of the results
  - Measurement in parallel with the existing visibility monitors „VisGuard“
- Mai 2007: After a successful trial period of 9 months we received the order to supply 210 FireGuard sensors
- Installation of the sensors in September 2007
Gotthard Tunnel: Installation

Installation density:
1 FireGuard / 96 meter
Gotthard Tunnel: Alarming concept

» Detection of the smoke, differentiation between a moving and a stationary object based on time differences of the alarm sequences.

» Compared to linear heat detection systems, smoke detectors show a very rapid response time.

» The FireGuard sensors are used to automatically execute the first alarm and initiate the necessary actions, based on a complex algorithm defined in the software.

Temperaturprofil, Rauchprofil und Windströmung im Tunnel
Project: City Ring West, Zurich / 2009
Project: City Ring West, Zurich / 2009

Key data:

» Bypass for the city of Zurich (traffic from Basel-Bern to Chur, A3)
» Connection Zurich-Lucerne (A4)
» Total length: 26.3 Km, 13.3 Km in tunnels
» Investment: 4 Bn. CHF / ~ 3.2 Bn. Euro
» Investment for the smoke detectors FireGuard, incl. installation: only approx 1‰(!) of the total investment

» Tunnels:
   › Eggrain, 470 m
   › Hafnerberg, 1.37 Km
   › Aescher, 2.15 Km
   › Uetliberg, 4.43 Km
   › Islisberg, 4.95 Km
Project: City Ring West, Zurich / 2009

Smoke- / Fire Detection:

» Installation of 301 FireGuard sensors on the ceiling near the dampers (every 100 meter)

» Additional 66 FireGuard sensors in the already existing «Gubrist» tunnel (upgrade)

» Early smoke detection using SIGRIST FireGuard sensor

» Linear heat detectors for fire detection
Projects concluded / planned

In brackets: number of sensors installed
Practical experiences

Typical values for visibility during the night and the beginning of a new day, «Gotthard» tunnel

Typical values measured for early fire detection:
Red line = 15mE/m
Practical experiences

› Truck with a defective turbocharger, developing strong smoke
› Truck was moving South, about 2.1 Km into the tunnel
› Air velocity direction North, 2.2 m/sec.
› Max. area covered with smoke: 2.5 Km
› Automatic reaction of the ventilation system, changing from an increased distributed suction to a concentrated suction
› Change of the flow direction towards the place where the truck stopped (S = 1.8 m/sec, N = 3.2 m/sec)
› Total time required to remove the smoke = 30 minutes
Practical experiences

- Evaluation of the alarm sequence, determination of the truck speed, localisation of the truck when it stopped
- 20:32:31 – Beginning of an increased distributed suction of the ventilation
- 20:35:51 – Change to a concentrated suction at the place where the truck stopped
January 27, 2012:
Due to a technical defect, a small truck caught fire in the «Saas» tunnel.

Note from the report published in the Swiss magazine: «Infrastruktur und Tunnelbau», edition 3/2013:

«The smoke sensors detected this incident 7 minutes earlier than the other installed fire detection system.»
Practical experiences

**Principle:** optimized parameter settings must be established individually for each tunnel installation!

- Parameterisation is complex and depends on:
  - Kind of tunnel (profil, single or two-way traffic)
  - Applied concept for the ventilation and fire
  - Traffic volume and vehicle mix (passenger cars / trucks)
  - Climatic conditions (e.g. salt spray in winter)

- **Sensitivity:**
  - Balance between system reaction vs. risk for false alarms!

- **Way of data handling and philosophy of alerting:**
  - Transmission of the raw data to the control centre, evaluation and reaction based on safety concept (Example: Gotthard – fully automatic release, incl. definition whether the object is moving or stationary)
  - Local evaluation and alerting
Practical experiences

- Basic requirements for maintenance:
  - One scheduled maintenance per year must be sufficient to guarantee a trouble-free function
  - Maintenance must be simple and fast
  - No parts subject to wear should be used

- Experiences with the „FireGuard“:
  - The only maintenance needed is to clean the measuring chamber
    - Sensors with heaters (tunnel entrance and exit): one cleaning / year
    - Sensors without heaters: cleaning only necessary every 2-3 years!
    - Integrated soiling monitoring
  - After the cleaning, an automated calibration is performed using a checking rod
  - Time required per sensor: max. 15 minutes
Visibility Monitoring

Reliable visibility monitoring has a name: VisGuard

Since more than 40 years SIGRIST also offers instrument for the visibility monitoring. More than 2’000 units of the current model «VisGuard» are in operation!
Thank you for your attention

FireGuard, the most genius fire detector: simple – safe - reliable
Video safety test tunnel «Saas»