

Safe Tunnel 2000

Integrated system for daily benefit and safety emergency use in tunnels

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This article presents new solution in solving safety problem in tunnels. With a new technology, we achieved that alert situation is detected in the earliest stage and automatically connected with the process of analyzing and fire extinguishing. Developed new technology of water fog extinguishing, new ventilation system and specially designed signal guidance is a base of this integrated system. SafeSystem is beneficial in a daily use and in an emergency situation in tunnels.

1 PROBLEM

We are facing a tunnel safety problem. Answer to why are the tunnel accidents happening more often than in the past, shows in statistics of increased number of tunnels and traffic in them.

We can accomplish safety in tunnels by looking at the problem as a whole. Each individual part designed for safety (ventilation, detecting systems, fire fighting etc.) affects the other and only as a complete interweaved system could really be safe.

There is a need to revise tunnel safety standards, since accidents in the past years show devastating results.

For example, there are no office buildings, hotels, or factories in the size of 160.000m² that would have one fire zone, no fire escape and no automatic fire fighting system. But in the contrary, long tunnels have no escape, no automatic fire fighting system, no immediate fire exit. Maybe we should think in a way that as soon as we step out of a car onto a road in a tunnel, tunnel becomes a building to us!

Cost of tunnel safety upgrade (SafeSystem for instance) could be compared to up to 2% of the construction cost; or tunnel safety upgrade is worth just about a month of the tunnel toll (where that is applicable).



Photo 1. Fire-fighters in Tauerer (A) were helpless; photo by M. Kunèè

Necessary addition to the safety equipment should enable:

- Precise surveillance of current situation in the tunnel, also in an emergency situation
- Measurements and analytical data with back-up for all parameters
- Complete system of informing and intervention in case of emergency
- Automatic fire extinguishing installation
- Communication among all operators, passengers and rescue teams with no language barrier
- Automatic detection of driving speed

In the tunnels we need to change or upgrade current practice of:

- Detection
- Monitoring- surveillance
- Ventilation

Necessary to add:

- Stable fire extinguishing system

2 SOLUTION TO THE PROBLEM

Here we will present the automatic system for detection, cleaning, prevention and fire extinguishing called SafeSystem.

2.1 *SafeSystem Description*

- SafeSystem is integrated system for daily benefit and safety emergency use in tunnel
- SafeSystem could be installed in new tunnels or more important to be installed quickly into existing tunnels in order to improve/upgrade safety

2.2 *New Technology in SafeSystem*

- SafeVIDEO (digital data communication, storage, processing)
- SafeFOG (1 nozzle covers 12 m circle diameter)
- SafeVENT (¾ times more exhausted air, air curtain)
- SafeSIGNAL (sign communication)

2.3 *SafeSystem Includes*

SafeVIDEO,
 SafeIR,
 SafeWATCH,
SafeFOG,
 SafeJET,
 SafeSHOWER,
SafeSIGNAL,
SafeVENT
SafeCEILING.

2.3.1 *SafeVIDEO*

Software for VIDEO supervision of a tunnel; simultaneously builds and manages a digital image archive.

2.3.2 *SafeIR*

Traffic surveillance in infrared spectrum.

2.3.3 *SafeWatch*

Software application for automatic surveillance with all cameras in a tunnel; control of irregularities.

2.3.4 *SafeFOG*

Water fog is fire-extinguishing media for all types of fire. SafeFog is a water fog fire extinguishing tunnel installation, which uses special SafeFog nozzles. SafeFog hi-pressure water nozzles are designed specially for tunnels and can cover diameter of 12m.



Photo 2. SafeFOG; Nozzle testing VIDEO OrbiPark

Water fog advantages:

- Safe for people
- Safe for the environment
- Effective gas, oil and electricity power stations fire extinguisher
- Isolating the burning material from oxidant
- Reduce rapid temperature of surrounding
- Water consumption about 10% of conventional sprinkler system
- Water FOG is binding the smoke and dangerous gasses
- Smoke binding and fire fighting ability could be increased by adding additives to the water fog

Benefits of SafeFOG:

- SafeFOG nozzles are able to produce large capacity of water fog, that means less nozzles needed per tunnel
- SafeFOG nozzles are unique on the market
- Tunnel hi-pressure piping installation could be controlled and open by sections

2.3.5 *SafeJET*

Periodical hi-pressure tunnel cleaning with SafeFOG system installation.

2.3.6 *SafeSHOWER*

Tunnel smog cleaning with SafeFOG system and cleaning of build-up exhaust at air cleaning vents.

2.3.7 *SafeSIGNAL*

Sign and communication system. SafeSIGNAL is a system for light alert and guidance. It serves also as a longitudinal measurement of temperature in a tunnel.

- Signal light for better road recognition in daily operation.
- Alarm trigger (every light) in a distance of 15m, for emergency case in a tunnel.
- Alert flashing light in a whole tunnel; prevention of a traffic jam.

- Longitudinal measurement of temperature in a tunnel, especially when all other systems of fire detection are “blinded”.

How SafeSIGNAL works:

- "Indicating sides of the tunnel-road " (normal, everyday use)
 - Partially activated light body (diode)
- "Speed restriction" (stroboscopic indication of driving speed)
 - Partially activated light body with additional function where individual lights flash in intervals, created is optical wave of specific speed; that helps regulating driving speed.
 - "Alarm" (alarming danger)
 - At this mode all diodes are flashing in a rhythm; alarm is activated at the spot of the accident and it means immediate stop for other cars in the tunnel
- "Control switch" for individual activating of the alarm (every 10 – 15 m)
- "Escape direction" (guiding towards escape direction)
 - Flashing lights towards safe area
- "Temperature measurement" (longitudinal measurement in the tunnel also under the fire)
- Possibility to connect other sensors

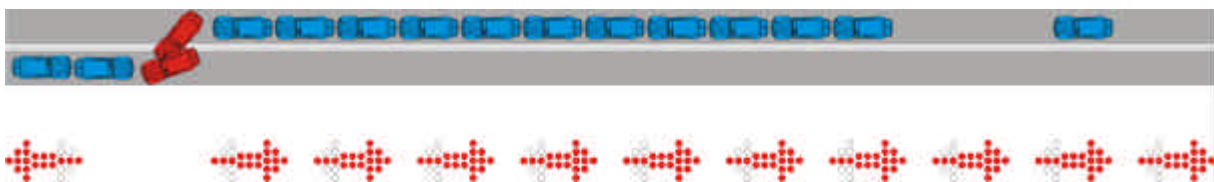


Photo 3. Two-way (one tube tunnel) tunnel; Safe Signal schematic presentation after the accident.

Illustration by Andrej Cufer

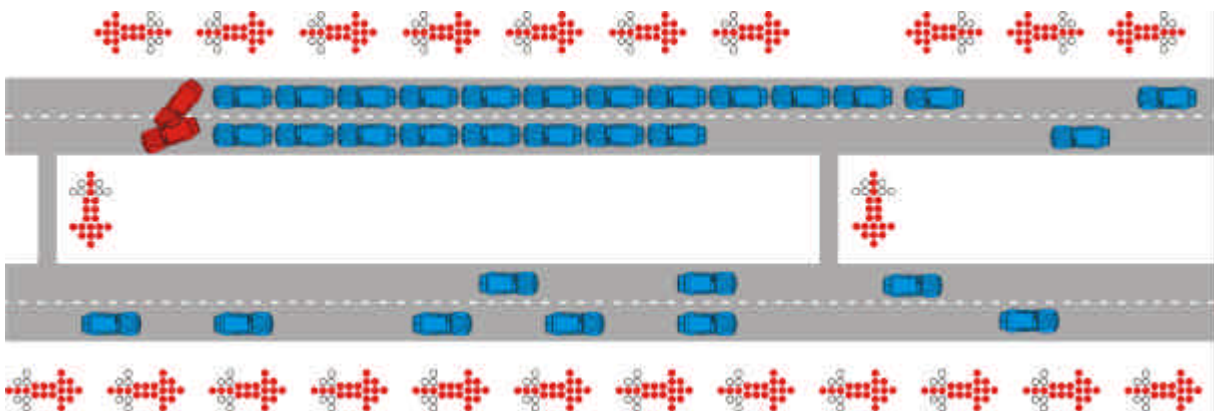


Photo 4. One-way (double tube tunnel) tunnel; Safe Signal schematic presentation after the accident.

Illustration by Andrej Cufer

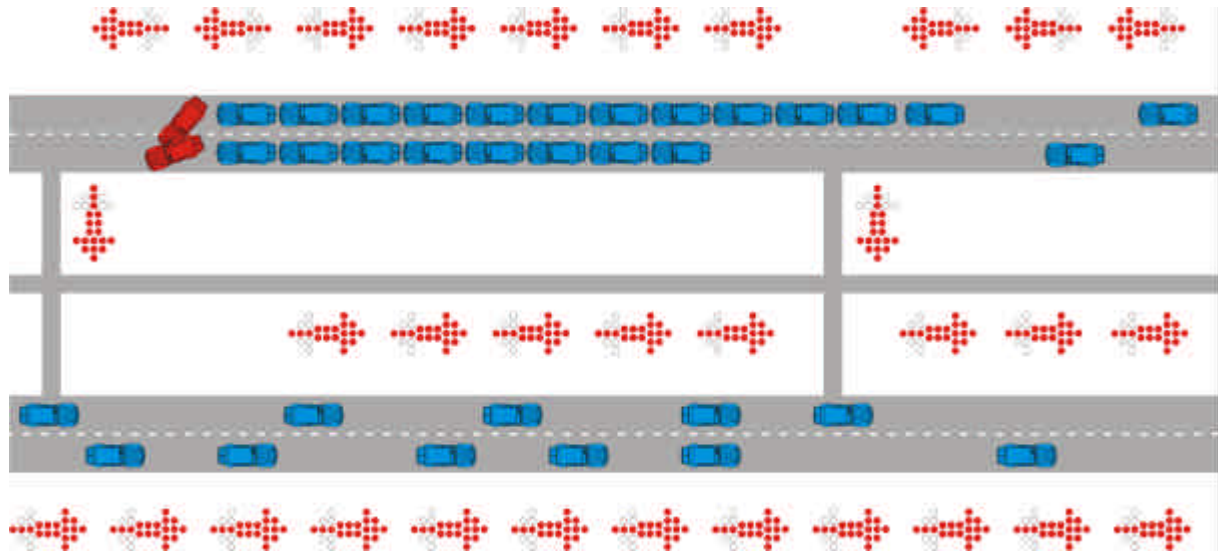


Photo 5. One-way + service tunnel (three tubes tunnel); Safe Signal schematic presentation after the accident. Illustration by Andrej Cufer

Composition of SafeSignal:

- SafeSIGNAL is composed of a metal frame / flute which is made of a stainless steel sheet metal in which active light body is installed.
- Lights (arrows) are arranged on a cable (electricity supply and communication).
- Lights are connected into one information system.
- Easy and fast assembling in a tunnel.
- Electricity supply and communication is possible from both ends of the tunnel.
- In case of disconnected cable SafeSIGNAL works as a whole unit over the alternative communication.

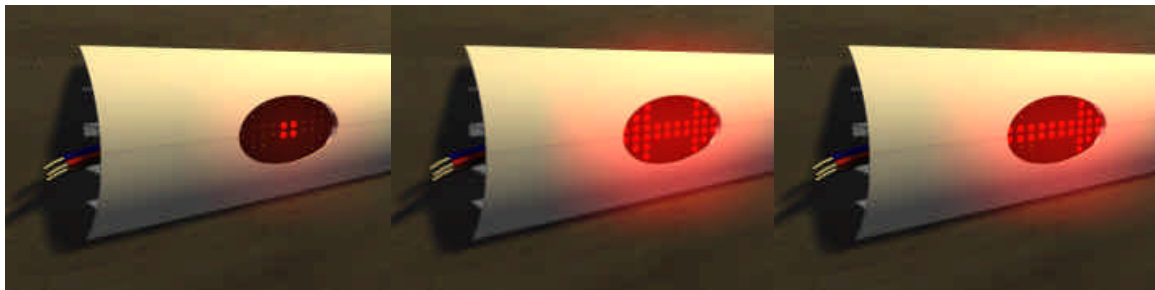


Photo 6. SafeSIGNALMODES; Rendering by J.Sovdat

2.3.8 SafeVENT

New ventilation system for a tunnel has three compartment parts above the suspended ceiling. Suspended ceiling has every 50m-ventilation grid in a whole tunnel width. Vent-grid is remotely controlled and moved (open or close) by water hydraulic (SafeFOG installation).

In normal operation system operates almost like cross section ventilation. The middle tube is providing fresh air and the two sides are used as exhaust tubes.

In fire mode all tubes are operating as exhaust tubes towards both ends of tunnel. They are able to extract out higher volumes of smoke as today's ventilations. Under the wide open vent-grid in front and behind fire the air

curtain enables escape of smoke towards people escaping the tunnel. The escape way to fresh air is no longer then 25m or if fire is under vent-grid in maximum of 50m.

First important part of SafeVENT system is that it doesn't allow fresh air to get all the way to the fire and second that creates in the area of fire "calm air" that is beneficial to water-fog extinguishing.

2.3.9 SafeCEILING

The standardization of safety installation will reduce the price of systems to be installed in tunnels.

The important part of tunnel protection is thermal isolation. The idea is to install in tunnels pre-build suspended ceiling, which can be installed fast and could be constructed in sandwich fireproof technology. Suspended ceiling is build out of vermiculite concrete and Promat special fireproof shields. This technology will stand the fire (2 hours) and protect installations in tunnel.

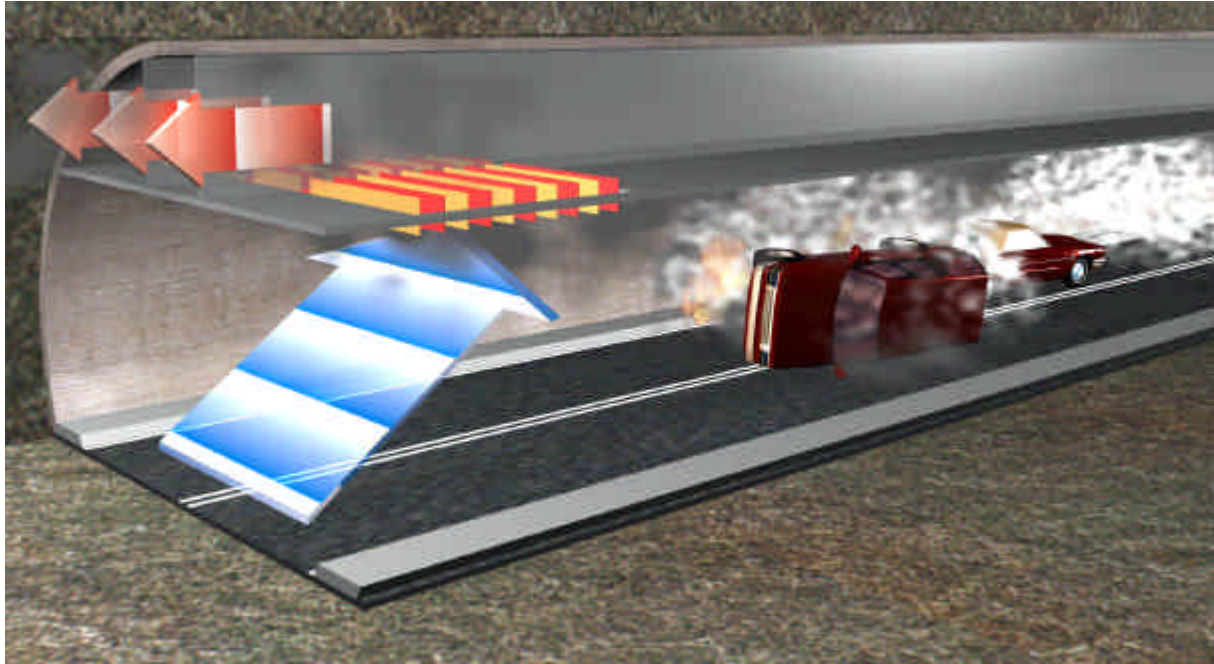


Photo 7. SafeVENT; Rendering by J.Sovdat

3 HOW SAFESYSTEM WORKS?

Here are steps of SafeSystem scenario in the case of fire:

1. If accident happen in a tunnel, all tunnel is set to alert mode immediately with SafeSIGNAL light (automatically detected, triggered by the operator, or driver) to inform drivers and prevent traffic chain building and additional car crashes.
2. SafeVENT is closing all vent-grids in tunnel except the ones in front and behind the fire. Direction of middle exhaust tube is reversing to exhaust ventilation direction. Two air curtains are rising in order to stop airflow in area of fire.
3. SafeFOG installation is opening bypass tubes in the area of fire; pressure in water supply tubes is building up. The fire fighting starts.
4. Fire brigade has up to 2 hours time to get to the emergency site.

First, second and third step could be accomplished in time up to 5 minutes. Installed system could control fire (up to 2 hours, or more depending on designed water reserves) and in most times extinct it. There is of course always a possibility of remaining small fire in the car where fog could not penetrate and that remains to be extinct by a fire brigade.

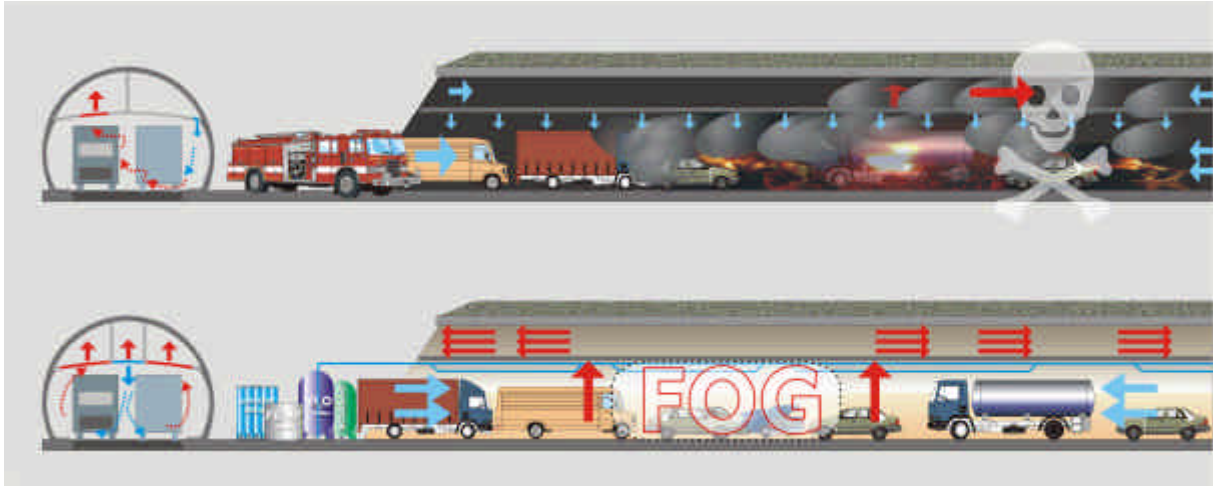


Photo 8. Top illustration: Current tunnel ventilation; Bottom illustration: SafeSYSTEM; Illustration by A.Cufer

4 CONCLUSION

Developed SafeSystem represents an integrated solution to an emergency situation in tunnel. Its advantages are based in a study of existing safety conditions in tunnels (existing ventilation systems, different fire sources, time frame for a fire brigade etc.) Goal of the system is to extinguished the fire in the earliest form and keeping the temperature down, controlling the spread of smoke with the ventilation and alerting all passengers with affective SafeSignal to stop from proceeding further towards the accident.



Photo 9. SafeSYSTEM; Rendering by J.Sovdat

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