EQUIPMENT FOR OPERATION AND SAFETY IN HIGHWAY TUNNELS

Rattei Günter
ASFiNAG
(Autobahn und Schnellstraßenfinanzierungsgesellschaft)

ABSTRACT

ASFiNAG plans, builds, maintains and levies the Austrian motorways and freeways. Currently ASFiNAG operates a road network of around 2045 km in length. Around 140km of special toll sections are on this road network, for example the Bosruck, Gleinalm, Arlberg and Tauern tunnels. A further 290km of motorways and freeways are currently in planning and construction. Considering all tunnels on the road network 130 tunnel facilities with a total length of around 285km are currently in operation. This corresponds to the distance from Vienna to Salzburg on the A1 West-motorway. Safety in motorway and freeway tunnels takes a very high priority in the ASFiNAG group due to this high proportion of tunnels in the total road network.

The catastrophes in 1999 (Mont Blanc and Tauern tunnel) have clearly demonstrated that tunnel safety should have been raised at the time. Proposals for improving tunnel safety have been prepared by various expert commissions and incorporated into the national guidelines. The implementation of these recommendations and guidelines and of the Road Tunnel Safety Act is one of the highest aims of the ASFiNAG group for ensuring the highest possible safety standards in all motorway and freeways tunnels. Decisive improvements to the operating and safety equipment in the tunnels have been achieved in emergency installations, for example, emergency call installations, escape/emergency services routes, lay-by niches, video monitoring etc.

The résumé of recent years clearly shows that the safety level in the Austrian motorway and freeways tunnels has clearly been raised due to an ambitious ASFiNAG tunnel safety investment programme.

1. INTRODUCTION

Tunnel safety has been significantly improved due to technical developments in recent years. This development drive was triggered by the tragic events of 1999. The topic of tunnel safety has been of high significance in the population since these events.

All operating and safety installations of the road tunnels have the raising of safety levels as their aim, so that maximum safety can be ensured for the tunnel users over the longest possible period in the event of emergency (e.g. fire).

2. OVERVIEW OF THE CURRENT EQUIPMENT STANDARDS FOR NEW TUNNEL CONSTRUCTION AND MODERNISATION

Major constructional and electromechanical installations which significantly influence the safety level and behaviour of the road users are:

- Emergency call installations in the tunnel and tunnel entrance area
- Construction and equipping of the fire fighting niches for the emergency services
- Design of the escape and emergency services routes
- Marking of the escape and emergency services routes
- Installations in the tunnel traffic areas
- Construction and installations of the lay-by niches
- Video monitoring
- Design of the tunnel entrance areas

This presentation will not go into further detail on further relevant safety installations such as ventilation, illumination, radio, etc.

2.1. Emergency call installations in the tunnel and tunnel entrance area

All emergency call installations in the tunnel are positioned in walkable and illuminated niches. The emergency niches are situated at intervals of around 250m in the tunnel on the right hand side seen from the driving direction. (Intervals between the emergency call niches were reduced to 125m due to the stipulations of the EU directive and of the Road Tunnel Safety Act.) A compact standing element including raceway, illumination, an outward opening door with safety glass and a fire extinguisher section is located in the structural niche. Opening of the doors is monitored by door contacts. The walkable emergency niche is equipped with a robust handset for making emergency calls. The functionality of the emergency installation is signalled to the emergency callers through an operation and malfunction display. The two fire extinguishers can be taken from the fire extinguisher section on the outside of the emergency cabin. Removal of the fire extinguishers is contact monitored and triggers a fire alarm upon removal. Furthermore, two hand hazard signals for SOS and fire reports are provided on the outside of the emergency cabin. The marking of the emergency niches in the tunnel traffic areas is carried out using internally illuminated emergency signs.

Emergency installations in the entrance areas are housed in closed cabins; the equipment is similar to that of the niches in the tunnel.

![Figure 1: Emergency call installations in the tunnel and in the entrance areas](image)
2.2. Construction and equipment of the fire fighting niches for the emergency services

All equipment items for fire fighting in the tunnel are housed in walkable and illuminated fire fighting niches for the fire service. The fire fighting niches are situated at intervals of around 125m in the tunnel opposite the emergency call niches. The equipment of the fire fighting niches is to be agreed with the local fire services. The fire fighting niches must however be at least equipped pursuant to the specifications of the Road Construction Guidelines and Regulations with a hydrant (B+C outlet with rigid coupling), B+C adapters, coupling tool, two hand fire extinguishers, and with at least 40m hoses in the areas of lay-by niches.

Figure 2: Fire fighting niches for the emergency services

2.3. Design of the escape and emergency services routes

Escape and emergency services routes are crossways in the neighbouring tunnel tubes or connections to the outside. Various types of crossways are differentiated in Austria. There are drivable crossways at every lay-by niche at intervals of around 1000m. Furthermore, there are crossways at intervals of 500m, which are only drivable with special vehicles of the emergency services and walkable crossways.

For connections to the outside, there is also a differentiation between drivable connections and walkable connections.

All escape and emergency services routes are separated from tunnel traffic areas by gates and doors and lit with the same luminance as in the tunnel roadways. Escape route orientation and signs lights lead to these escape routes.

Figure 3: Design of the escape and emergency services routes
2.4. **Marking of the escape and emergency services routes**

Marking of the escape and emergency services routes is carried out using internally illuminated escape route signs and escape route orientation lights. Escape route orientations lights are mounted at intervals of 50m at 1m height over the raised shoulder. Escape route orientation signs are mounted opposite these lights at intervals of 25m.

![Figure 4: Marking of the escape and emergency services routes](image)

2.5. **Installations in the tunnel traffic areas**

The most important installations in the tunnel traffic areas are installations for the traffic directing and monitoring. These are traffic light signal equipment, lane marker signals, traffic signs, directing installations, video monitoring, etc. The illumination, information equipment (loudspeaker systems and tunnel radio), emergency call installations, extinguisher installations and automatic fire alarm equipment represent also important installations for increasing safety in the tunnel traffic areas.

![Figure 5: Installations in the tunnel traffic areas](image)
2.6. Equipment and installations in the lay-by niches

Lay-by niches are provided every 1000m in the tunnel. The lay-by areas are around 40m in length and 3m in width. The illumination level in the lay-by niches is clearly higher than that of the roadways, whereby these areas are clearly highlighted in the tunnel. Important operating and safety installations such as yaw/pitch/zoom cameras, wall hydrants, loudspeaker systems, fire fighting niches, emergency call niches etc. are fitted in the area of the lay-by niches. Distance indicators to the portals are provided on the tunnel walls in the lay-by niches.

![Figure 6: Equipment and installations in the lay-by niches](image)

2.7. Video monitoring

Systems for automatic video monitoring and video detection raise the safety level of a tunnel significantly due to the short detection times. The entire roadways and critical areas such as emergency niches, lay-by niches, escape/emergency services routes and portal areas are monitored. Monitoring is performed in critical areas with yaw/pitch and zoom cameras. All images from all cameras are evaluated and transmitted to the tunnel monitoring-centre.

2.8. Design of the tunnel entrance area

Measures for safe traffic direction and better information of the road users are provided in the area of the tunnel entrance areas. Measures for safe traffic routing are for example traffic direction installations, traffic lights, dynamic information signs, setup of a speed reduction funnel etc. Optimal design of and protective measures for the tunnel entrance areas significantly contribute to increasing tunnel safety.
SUMMARY

The résumé of recent years clearly shows that due to an ambitious ASFiNAG tunnel safety investment programme (around €210 million in 2006) the safety level in the Austrian motorway and freeway tunnels has been clearly raised since 1999. The tendencies in tunnel safety in coming years are for example reduction of the intervals of escape and emergency services routes, retrofitting with wall hydrants, centralisation of tunnel monitoring etc. The developments in tunnel safety should however not only be limited to systems for detection, combating and minimisation of effects. Targeted information programmes and education of the road users in correct behaviour in road tunnels should definitely be performed in coming years to be able to bring about a further improvement of safety levels.