

SAFETY IN ROAD TUNNELS : SHOULD WE EDUCATE THE USER TO THE TUNNEL ? OR ADAPT THE TUNNEL TO THE USER IN PANIC ?

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ABSTRACT

The presentation shows the main points of the actions undertaken, and their consequences, in various countries, focuses then on the aspects of human behaviour, based on the work of the corresponding Working Group of PIARC : training of the user of course, but also training of the operator, of the rescue services, the taking into account of the specificities of tunnels in the driving schools (as well for the «common» users as for the «road professionals»), in the technical control centres for vehicles, etc.

INTRODUCTION

Tunnels are more and more used for allowing roads and railways to cross natural barriers such as mountain chains, rivers and canals, or even straits. The environmental problems and the restricted urban space result also in carrying out underground facilities such as mass transit systems, railway and road tunnels. In general, tunnels became vital parts of the land transport networks. Many of them ensure vital economic links and allow to carry out high-ranked political aims for mobility of people and goods.

A recent study by the Academy of Sciences of Vienna indicates that private motoring in Europe will rise by around 20 % by the year 2010 compared with 1997, and by as much as about 40 % by 2030. Other forecasts indicate that goods traffic in Europe will rise by about 60 % during the next 30 years.

Against this background it is imperative that new logistics concepts, new ways to secure mobility and also new supplementary measures to improve the infrastructure are found. One of the solutions is certainly to use the chances afforded by the underground. Latest statistical data give rise to the expectation of substantial tunnelling activities on a world-wide scale over the next 10 to 15 years : the European tunnelling market can expect a total construction volume of around 2 100 km of transport tunnels. Statistics relating to the Asian market indicate a volume of around 2 350 km. Roughly 650 km is scheduled for construction in South America and at least the same magnitude on the North American continent. Australia and northern and southern Africa

are also planning tunnelling projects, although to a less degree.

The presentation will first show the main points of the actions undertaken, and their consequences, in various countries.

It will further focus on the aspects of human behaviour, based on the work of the corresponding Working Group of PIARC : training of the user of course, but also training of the operator, of the rescue services, the taking into account of the specificities of tunnels in the driving schools (as well for the «common» users as for the «road professionals»), in the technical control centres for vehicles, etc.

The debate will finally be opened on the design of tunnels starting from the knowledge acquired on the behaviour of users in case of incident in a tunnel : as the panic reactions are better known and understood, should one not take them into account in the design of new achievements or in the improvement of existing ones ?

SAFETY IN ROAD TUNNELS BEFORE THE ACCIDENTS OF 1999-2001

Road safety in general, and specially safety in road tunnels, has for long been the competence of national, or even local authorities. If there has been since a few decennia some harmony in Europe and even in the world in the field of signalisation (meaning the way of indicating a regulation or giving information, compulsory or not), inter alia thanks to the efforts of the ECE/UNO², the basic rules remain most of all national.

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Three typical examples in Europe are the colour of signalling to and on the motorways, the speed limits on roads and motorways, and even left or right driving.

Normalisation activities were not inexistent, but the regulations could not be made compulsory out of national borders.

This was also the case for the equipment of road tunnels, where mainly the Road Tunnel Committee of PIARC³ had produced since long recommendations about the types of equipments to use. But it were only recommendations, and each country or even each operator remained free to implement them or not. These activities thus got the attention only from the professionals, but not from the general public.

THE ACCIDENTS OF 1999-2001 IN EUROPE AND IN THE WORLD, IN ROAD- AND OTHER TUNNELS

The dramatic fires that happened during the five last years took mostly place in road tunnels : the Mont Blanc Tunnel (France/Italy, 1999; 39 fatalities), the Tauern Tunnel (Austria, 1999; 12 fatalities), the Gotthard Tunnel (Switzerland, 2001; 11 fatalities).

Let us however not forget the much more dramatic fires in the funicular tunnel of the Kitzsteinhorn (Austria, 2000; 156 fatalities), and in the metro of Daegu (South Korea, 2003; 196 fatalities).

THE NATIONAL AND INTERNATIONAL ACTIONS UNDERTAKEN SINCE 2000

These catastrophes have had a large echo in the public opinion, specially in Europe. The political authorities have so started to be involved in tunnel safety, what led to a strong request for its improvement. Numerous other initiatives have then been launched at various national, European and international levels : for road tunnels it mostly concerns (in chronological order of their actions) the ECE/ONU, the EU⁴ and the numerous European research programmes and thematic networks, as DARTS⁵, FIT⁶, UPTUN⁷

Their objectives are to set up recommendations and reinforced, if possible internationally harmonized regulations, as well as the starting of new research to improve the understanding of fires in tunnels and to limit their consequences.

1. Economical Commission for Europe of the United Nations (ECE/ONU)

The ECE/UNO includes representatives from all European countries from the Atlantic to the Ural. It also administers international legally binding instruments, including the European Agreement on Main International Traffic Arteries (AGR), the Vienna Conventions on Road Traffic and on Road Signs and Signals, the 1958 and 1998 Agreements on Vehicle Regulations and the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).

In February 2000, the ECE/UNO Inland Transport Committee, the highest ECE/UNO transport body, approved the creation of the Ad hoc Multidisciplinary Group of Experts on Safety in Tunnels. The creation of the Group was supported by the European Commission. The Group was given the mandate to elaborate, on the basis of best national practices and international knowledge, recommendations to reduce the risk of accidents in road tunnels of various types and lengths, while maximizing the economic efficiency of their construction and operation.

The first task of this Group of Experts was to launch a questionnaire in order to have an up-to-date picture of European road tunnels and of existing tunnel safety legislation. The Group decided to confine its work to tunnels over one kilometre in length. The survey showed that in Europe there are about 700 road tunnels longer than 1 km, of which 8 tunnels are longer than 10 km. A large number of these tunnels are on the E road network which is defined in the AGR Agreement.

The report of the ECE/UNO Group of Experts contains 43 Recommendations to which 2 more, prompted by the Gotthard Tunnel fire in October 2001, were added in January 2002, bringing the total number to 45. The Recommendations are structured in 4 categories reflecting the main factors influencing tunnel safety.

Give that human error is the main cause of accidents, the Group recommended that measures addressed at road users be implemented on a priority basis. They include information campaigns and other measures that target the behaviour of drivers and their training. In the Mont-Blanc fire drivers died in their cars or close by them because they did not know how to react to the fire in front of them. In these measures particular attention is paid to the drivers of heavy vehicles.

The second group of measures concerns tunnel operation and management. Among the measures proposed is the creation of a national coordinating body, the appointment

of a safety officer for tunnels longer than 1 km and the regular undertaking of rescue exercises and trials.

The third group of measures concerns the infrastructure. These include criteria for the number of tubes and lanes, emergency exits, ventilation, connections between tubes in twin-tube tunnels, etc. and for equipment and signs.

The fourth group of measures is for vehicles and particularly for heavy vehicles. They include recommendations regarding the quantity of fuel carried, the fire resistance of fuel tanks and the use of highly inflammable materials in the construction of vehicles.

In February 2002, the Inland Transport Committee approved the Recommendations, invited Governments, the EC and organizations to implement them and requested its subsidiary bodies to consider their introduction into the legally binding instruments administered by them.

One can say, without going into details, that amendments are under preparation

- * to the Vienna Conventions on Road Traffic and on Road Signs and Signals to introduce rules to be respected by drivers when they have to make an emergency stop in a tunnel and to incorporate new signs including for emergency stopping places and emergency exits ;
- * to the AGR introducing a new chapter on management, safety equipment and general arrangements for tunnels, which includes stricter requirements regarding access to the profession of road transport operator ;
- * to the ADR to include tunnel safety in the training of drivers of dangerous goods. Work is continuing on the possible incorporation into the ADR of the OECD-PIARC proposal for groupings of dangerous goods whose transport is allowed in tunnels.

The Recommendations of the Group of Experts can be consulted on the website of the UNECE Transport at the following address: <http://www.unece.org/trans/doc/2002/ac7/TRANS-AC7-09e.doc>.

2. European Union (EU)

a. Procedure

In its White Paper on transport policy, the European Commission emphasises the need to consider a European Directive on minimum safety requirements to guarantee a high level of safety for the users of

tunnels, particularly those in the trans-European road network (TERN). The fires in the Mont Blanc and Tauern tunnels in 1999 and in the Gotthardtunnel in 2001 demonstrated an insufficient safety level of certain road tunnels and have put the risks in road tunnels in the spotlight again and have called also for decisions at political level.

In order to prevent accidents/incidents and to limit the consequences of them, if they occur, a new Directive 2004/54/EC (in the following the Directive) fixes for existing and future tunnels over 500 m length on the TERN minimum safety requirements. It details the duties and the responsibilities for the owner of a tunnel, whether that is a public or private operator, and also fixes a number of traffic requirements. To provoke suitable and rapid reactions, an accent is also put on information and communication. In order to inform the users on best behaviour harmonized information campaigns are envisaged in the future and proposals for a harmonized signalisation in all incident cases in road tunnels are given.

In nearly all European Union Member States there are tunnels which fall within the scope of the Directive. A total of 515 TERN tunnels more than 500 m in length were identified in 2002, around 50% of which are located in Italy. A number of them have been built to specifications that with time have become outdated; either their equipment no longer corresponds to the state of the art or traffic conditions have substantially changed since their initial opening.

co-ordination has been identified as a contributory factor to accidents in trans-border tunnels. The Directive stipulates therefore that all the emergency organisations will have to be associated with the preparation of intervention and rescue plans, which will have to be established under the responsibility of a safety officer for each tunnel.

Moreover, recent serious accidents show that non-native users are at greater risk of becoming a victim in an accident, due to the lack of harmonisation of safety information, communication and equipment.

The proposal for a Directive was prepared by the Commission, and forwarded to the Council and the European Parliament at the end of 2002. Between February and September 2003 a Council working group came at the end to a global common proposal, which was approved in Council on the 9th of October 2003. The European Parliament accepted a report

with 75 amendments. This amended final proposal was adopted in April 2004. The Directive was published in the Official Journal of the European Union on the 30th of April 2004 and entered into force at that very date, implying that it has to be transposed in national legislations in the 25 countries before the end of April 2006.

b. Content

The primary objective of the Directive is the prevention of critical events that endanger human life, the environment, tunnel structure and installations.

The secondary objective is the reduction of possible consequences of events such as accidents/incidents by providing the ideal pre-requisites for :

- enabling people involved in an accident/incident to rescue themselves ;
- allowing immediate intervention of road users ;
- ensuring efficient action by emergency services ;
- protecting the environment ;
- limiting material damage.

c. Organisational requirements

Considering that the diversity of organisations involved in managing, operating, maintaining, repairing and upgrading tunnels increases the risk of accidents, the Directive harmonises the organisation of safety and clarifies the different roles and responsibilities. In particular, the Directive asks that each Member State appoints an administrative authority which is the competent authority responsible for all safety related aspects of a tunnel, assisted by an inspection entity for commissioning visits and periodical technical inspections. In most cases, Member States will have the possibility of appointing existing administrative services as administrative authorities for the purposes of the present Directive. Responsibility for safety in each tunnel will lie with the Tunnel Manager and the responsibility for control with an appointed Safety Officer.

d. Technical requirements

The proposed technical requirements are based on works done in international bodies e.g. PIARC and the ECE/UNO).

The safety level in tunnels is influenced by a number of factors that can be classified in the following four categories : infrastructure, operation, vehicles and road

users. The Directive takes into account the infrastructure, the operation, and the road users.

The minimal requirements included in the Annexes of the Directive are firstly based on the traffic volumes and the length of the tunnel, and include all structural components, ventilation and the other electromechanical equipments. The Member States can impose more strict requirements, on the condition that they do not contradict the requirements of the Directive. Limited deviations of these minimal requirements can be accepted for a specific Member Country, on condition that a procedure has been followed, which includes the participation of the Commission and all the other Member States.

The following tables give informative summaries of the minimal requirements for the structural safety measures (table 1) and the measures concerning the safety equipments (table 2).

e. Operational requirements

In the event of a serious accident or incident, all appropriate tunnel tubes shall be closed immediately to traffic. This shall be done by simultaneous activation not only of the above-mentioned equipment before the portals, but also of variable message signs, traffic lights and mechanical barriers inside the tunnel, if available, so that all the traffic can be stopped as soon as possible outside and inside the tunnel.

The access time for emergency services in the event of an incident in a tunnel shall be as short as possible and shall be measured during periodic exercises. In the event of an incident, the Tunnel Manager has to work closely together with the emergency services. Emergency services must at least be consulted when defining operation of the tunnel in emergency cases and emergency response plans.

f. Information of the road users

In-depth analyses of incidents on roads show that an accident is the consequence of one or more faults in a complex system involving drivers, vehicles, the road and its surroundings. Thus, efforts to increase the level of road safety have to aim primarily at preventing human error. The second step will have to ensure that errors made by drivers do not have serious consequences. There are various ways of having a direct or indirect influence on the way people act.

The Directive calls for better information for road users on tunnel safety, e.g. through information campaigns at national level and improved communication between the Tunnel Manager and road users inside a tunnel. On the

2. ECE/UNO : Economical Commission for Europe of the United Nations (Geneva)

3. PIARC : World Road Association (Paris)

4. eu / European Union (Brussels)

5. DARTS : Durable and reliable Tunnel Structures

6. FIT : Fire in Tunnels

7. UPTUN : Cost-effective, sustainable and innovative upgrading Methods for Fire Safety in existing Tunnels

Table 1 - Informative summary of structural safety measures

| | | | Traffic < 2000 veh/lane | | Traffic > 2000 veh/lane | | | Additional conditions for mandatory implementation, or comments |
|---------------------|--|---------------------|-------------------------|----------|-------------------------|-------------|----------|--|
| | | | 500-1000 m | > 1000 m | 500-1000 m | 1000-3000 m | > 3000 m | |
| Structural measures | 2 tubes or more | §2.1 | | | | | | Mandatory if a 15 years forecast shows a traffic >10000 veh./lane |
| | Gradients < 5 % | §2.2 | * | * | * | * | * | Mandatory unless not geographically possible |
| | Emergency walkways | § 2.3.1 § 2.3.2 | * | * | * | * | * | Mandatory when there is no emergency lane ; in existing tunnels where there is neither an emergency lane nor an emergency walkway, additional/reinforced measures shall be taken |
| | Emergency exits at least every 500 m | § 2.3.3- § 2.3.9 | 0 | 0 | * | * | * | Implementation of emergency exits in existing tunnels to be evaluated case-by-case |
| | Cross-connections for emergency services at least every 1500 m | § 2.4.1 | 0 | 0/* | 0 | 0/* | * | Mandatory for twin tunnels > 1500 m |
| | Crossing of the central reserve outside each portal | § 2.4.2 | * | * | * | * | * | Mandatory for twin tunnels bi-tube where geographically possible |
| | Lay-bys at least every 1000 m | §2.5 | 0 | 0 | 0 | 0/* | 0/* | Mandatory in new bi-directional tunnels > 1500 m without emergency lanes ; in existing bi-directional tunnels depending on analysis |
| | Drainage for inflammable and toxic liquids | §2.6 | * | * | * | * | * | Mandatory if transport of dangerous goods is allowed |
| | Fire resistance of the structures | §2.7 | * | * | * | * | * | Mandatory if a local collapse can have catastrophic consequences* |

basis of the work of PIARC the Commission produced 2 information leaflets on how to react in accident/incident cases in tunnels.

As recent accidents show that self-rescuing offers the highest potential for saving lives in the case of an accident in a tunnel, the introduction of clear and self-explanatory signs in sufficient numbers indicating the safety equipment in each tunnel is an important measure that can be implemented at relatively low cost. Therefore in addition, the Annexes contain also a description of, and requirements for, the positioning of obligatory road signs, panels and pictograms relating to safety.

g. Follow-up

The Commission will set up a committee which may then decide to create a working group of national experts from the Member States, third countries and competent organisations with the following objectives:

- to gather the data needed to prepare a harmonised procedure for risk analysis if necessary ;
- to prepare further improvements to the minimum safety provisions for construction, operation, maintenance, repair, upgrading, rehabilitation and refurbishment of tunnels of various types and lengths, and to improve traffic conditions in these tunnels, e.g. signs, restrictions on vehicles and dangerous goods, driver training ;
- to collect information on safety provisions in tunnels, in particular on new traffic management techniques.

Table 2 - Informative summary of safety equipment

| | | 0 Non Mandatory ⊖ | Traffic < 2000 veh/lane | | Traffic > 2000 veh/lane | | | Additional conditions for implementation to be mandatory, or comments |
|----------------------------------|---|----------------------|----------------------------|-------------|-------------------------|----------------|-------------|--|
| | | | 500-1000 m | > 1000 m | 500-1000 m | 1000-3000 m | > 3000 m | |
| Lighting | Normal lighting | §2.8.1 | • | • | • | • | • | |
| | Safety lighting | §2.8.2 | • | • | • | • | • | |
| | Evacuation lighting | §2.8.3 | • | • | • | • | • | |
| Ventilation | Mechanical ventilation | §2.9 | 0 | 0 | 0 | • | • | |
| | Special provisions for (semi-) transversal ventilation | §2.9.5 | 0 | 0 | 0 | 0 | • | Mandatory in bi-directional tunnels with control centre |
| Emergency stations | At least every 250 m | §2.10 | • | • | • | • | • | Equipped with telephone and 2 extinguishers |
| Water supply | At least every 250 m | §2.11 | • | • | • | • | • | If not available, mandatory to provide sufficient water otherwise |
| Road signs | | §2.12 | • | • | • | • | • | For all safety facilities provided for tunnel users (cf. annexe III) |
| Control centre | | §2.13 | 0 | 0 | 0 | 0 | • | Surveillance of several tunnels can be centralised in a single control centre |
| Monitoring systems | Video | §2.14 | * | * | * | * | • | Mandatory when there is a control centre |
| | Automatic incidents and/or fire detection | §2.14 | • | • | • | • | • | At least one of the two systems is mandatory in tunnels having a control centre |
| Equipment to close the tunnel | Traffic signals before the entrances | §2.15.1 | 0 | • | 0 | • | • | |
| | Traffic signals inside the tunnel at least every 1000 m | §2.15.2 | 0 | 0 | 0 | 0 | ⊖ | Recommended if there is a control centre and if the length exceeds 3000 m |
| Communi-cation systems | Radio re-broadcasting for emergency services | §2.16.1 | 0 | 0 | 0 | • | | |
| | Emergency radio-messages for the users | §2.16.2 | • | • | • | • | • | Mandatory if radio is rebroadcast for tunnel users and if there is a control centre |
| | Loudspeakers in shelters and exits | §2.16.3 | • | • | • | • | • | Mandatory when evacuating users must wait before they can reach the outside |
| Emergency power supply | | §2.17 | • | • | • | • | • | To insure the functioning of the indispensable safety equipments at least during the evacuation phase |
| Fire resistance of equipments | | §2.18 | • | • | • | • | • | Shall aim to maintain the necessary safety functions |

3. Research Programmes and Thematic Networks

An important number of research projects were also initiated by the European Commission. They are multinational projects awarded and funded within the fifth Research Framework Programme of the European Union.

Durable And Reliable Tunnel Structures (DARTS) started in March 2001 and ended in early 2004. The initiative included eight European partners and was structured into six technical work packages. It was primarily dedicated to the problem of exceeded cost during the construction of underground transport facilities. Furthermore, the quality and lifetime of tunnels as the most cost-intensive component of the entire traffic infrastructure was to be improved. For more information see www.dartsproject.net and the more detailed adjoining article.

Fire in Tunnels (FIT) was established in March 2001 for four years. This is a «thematic network» which includes 33 partners from twelve European countries. It gathers information from all over Europe and around the world about existing research results and general experiences with fire safety in transport tunnels and makes recommendations. For more details see: www.etnfit.net and the adjoining article.

Cost-effective, sustainable and innovative Upgrading Methods for Fire Safety in existing Tunnels (UPTUN) is designed as a research and development project for four years and was started in September 2002. 41 partners from 16 European countries are part of this co-operative effort. The principal goals of this large-scale project with a budget of approximately 12 million euros are described in the adjoining article. For further details see www.uptun.net.

Innovative Systems and Frameworks for Enhancing of Traffic Safety in Road Tunnels (Safe Tunnel), began in September 2001 for a project term of three years involving nine partners. This research project will primarily contribute to reducing the extent and number of accidents in road tunnels with the help of preventive safety measures. For further details see www.crfproject-eu.org.

Virtual Fires (Virtual Real Time Emergency Simulator) also started in 2001 for a duration of three years with eight partners from five European countries. The objective is to develop a suitable and practical simulator to train fire fighters in confining and fighting fires in tunnels. A computer model will be used to create virtual simulations of fires in tunnel situations. For more information visit:

www.virtualfires.org.

Safety in Tunnels (Safe-T) is another thematic network with a three-year term started in the end of 2003. The primary objective is to harmonize the European requirements regarding tunnel safety. Experiences gathered at national level are to be compiled and assessed. For further details see www.safetunnel.net.

Safety Improvement in Road & Rail Tunnels using Advanced Information Technologies and Knowledge Intensive Decision Support Models (SIRTAKI) was initiated in September 2001 for a term of three years. The initiative is shared by twelve European partners. The main focus of the project is to reform operative concepts with regard to safety and emergency management. For further details see www.sirtakiproject.com.

THE ACTIONS REGARDING HUMAN BEHAVIOUR AND THE BEHAVIOUR OF USERS IN CASE OF INCIDENT, ACCIDENT AND FIRE

Previous chapters, and specially those concerning ECE/UNO and EU, have shown sufficiently the capital role played by human behaviour in traffic in general, and in tunnel safety in particular.

The most detailed study of human behaviour has been done by an ad hoc Working Group of the Committee of Operation of Road Tunnels of PIARC.

The most important points are quoted hereafter.

1. Behaviour of drivers and passengers

The observations and investigations of the Gotthard tunnel fire in October 2001 showed once again that human behaviour is crucial for the limitation of consequences of a fire. The users, which did not survive the incident, either stayed in their vehicle or tried to save their vehicle rather than their live or left too late their vehicle to reach existing exits to the emergency gallery. This wrong human behaviour lead to the conclusion that it is urgently necessary to launch an information campaign using international harmonised information of experts including those of traffic psychologists and public relation experts.

In the aftermath of the Mont Blanc and Tauern tunnel incidents a considerable number of different national information leaflets were distributed for information of tunnel users. Among them were also those asking the users in case of smoke in the tunnel «to close their windows, shut down the air intake and restrain from

smoking». This contra-productive information may lead users to believe they can survive in their vehicles. In some leaflets human behaviour was asked for rules, to which, according to psychologists, nobody will respond, if it can not be controlled and enforced. Therefore a harmonised approach using also these experiences and also the expertise of information and communication specialists is urgently necessary.

The EU information campaign throughout the Member states will include the above mentioned EU-leaflet «Safe driving in Road Tunnels» and two videos prepared on behalf of the Commission: one on human behaviour based on the leaflet and the other one on minimum requirements of tunnel safety for the Trans-European Road Network (TERN). The leaflet includes on the front page a short introduction into the minimum safety equipments of road tunnels and most important on the back page recommendations for best behaviour of road tunnel users. This campaign will use the information channels used by the Commission as well as those of associated and interested parties in the Member states.

2. Leaflets

A common proposal for an information leaflet for non-professional tunnel users was developed after a common work of PIARC and ECE/UNO, and published in 2002 by the European Commission in the 11 languages of the member countries.

In spite of the many discussions on the use of mobile phones in tunnels, this topic is actually not yet resolved. Some countries have forbidden the use of this devices in tunnels in order to push users to use existing emergency phones in tunnels in order to allow there immediate localisation and so shorten the alarm times. It will be hard to ask the public to act against the technological main stream of using this devices to restrain from using it also in tunnels. «It is harder to change human behaviour than to invent new technologies».

It is however clear that all emergency calls from inside a tunnel should automatically go directly to the tunnel operation centre.

3. Driving schools

There are in no countries neither driving examinations including questions about behaviour of users in case of incident/accident in a road tunnel, nor written recommendations on the way drivers should behave when they detect smoke or a fire in their own vehicle

or when they drive through a tunnel. In only few countries there are information and recommendations about the best behaviour in tunnel, as well as specific data about incorrect behaviour of drivers. In most of the countries regulations exist for control and implementation of driving rules, even in road tunnels.

4. Professional drivers

As the initial stages of a fire are the most critical, there is also a need to investigate what the users, and here especially professional drivers, can do to fight the fire and reduce its consequences. Therefore it was felt necessary that professional drivers should know more about behaviour in tunnel environments than the normal driver, and should be considered as examples to follow in case of incident.

5. Tunnel operators

As it appears that in some tunnel fires the human reaction of the operators and the fire fighting services was crucial, it seemed needed to take into account all other categories of people whose behaviour is important. The qualifications of controllers have to be re-evaluated. Therefore it was decided to develop a guide for the best practice of tunnel operators in accident/incident cases. This manual includes the following points :

- detection
- information
- action
- intervention

In general, the majority of European road tunnels operated from manned control centres have already automatised help systems that optimise the work of the operator. In all cases the operators must follow strict procedures in case of incidents. These vary in complexity, but operators must in general follow the same constraints in all control centres.

6. Intervention forces

It is not the aim to tell the intervention forces what to do in case of incident, but try to rectify some of the basic misconceptions commonly held by these services with respect to road tunnels and their equipment. The aim is not to provide a guide, but an information of tunnel equipment and operations with special emphasis of the views of these services.